REMARKS

The present invention relates to a process for the production of oil and petroleum-resistant (polyurea)polyurethanes, the products of this process and articles made from the products of this process. In the process of the present invention, (1) a polyether polyol component which includes both a diol and a triol satisfying specified criteria, (2) a polyester polyol satisfying specified criteria, (3) a polyisocyanate and (4) a chain extending agent are reacted, optionally in the presence of other additives, at an isocyanate index of from 70 to 130.

Claims 12, 13 and 16 stand rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. The specific basis for this rejection is that adequate support has not been provided for the amendment to Claim 12 specifying the sum of the mole percents. Applicants respectfully traverse this rejection.

The mole percents in Claim 12 specify the percentage of each of the listed acids and diols present in the polyester polyol component. One skilled in the art would readily appreciate that the total mole percent of a single component must be 100%, i.e., the total component. This is clearly demonstrated by the description of the preferred polyester polyol components described at page 5, line 25 through page 6, line 2 of the specification. The sum of each of the three preferred polyester polyol components is clearly 100 mole percent.

Claims must be read as they would be read by one of ordinary skill in the art. One skilled in the art would readily appreciate that the sum of the molar percentages recited in Claim 12 must be 100 mole percent of the polyester polyol component. Applicants' claims do therefore satisfy the description requirement of 35 U.S.C. § 112, first paragraph.

Withdrawal of this rejection is therefore requested.

Claims 11-22 were further rejected under 35 U.S.C. § 112, first paragraph, on the basis that the specification was not enabling. The specific basis for this rejection is that Applicants have relied upon a foreign test standard to set forth the oil and petroleum resistance of the composition. Applicants have not established a correlation between the foreign standard and a U.S. standard nor have Applicants provided English documentation describing the standard.

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A copy of DIN EN 344 in English is enclosed. It is believed that this submission removes the basis for this rejection.

Withdrawal of this rejection is therefore requested.

Claims 11, 15, 17-19 and 21 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Mao (U.S. Patent 4,124,572). Applicants respectfully traverse this rejection.

Mao discloses thermoplastic polyurethane elastomers produced from a reaction mixture which includes a poly(oxypropylene)-poly(oxyethylene) glycol (molecular weight from 1000 to 3000) containing 25-60% by weight of oxyethylene groups, a polyester polyol (molecular weight from 1000 to 3000), a polyisocyanate and a chain extender.

Mao does not teach a polyether polyol component which includes "at least one polyether triol" of the type required in Applicants' invention. The only polyethers disclosed by Mao are glycols, i.e., diols. (See enclosed definitions taken from Grant & Hackh's Chemical Dictionary, pages 265 and 266.)

Mao does not therefore disclose Applicants' claimed invention in the manner necessary to support a rejection under 35 U.S.C. § 102(b).

Withdrawal of this rejection is therefore requested.

Claims 14, 20 and 22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mao (U.S. 4,124,572). Applicants respectfully traverse this rejection.

Applicants' claimed invention requires a polyether polyol component which includes both a diol and triol. Mao does not even mention polyether triols satisfying the compositional requirements of Applicants' required triol much less suggest that there would be any reason to include such a triol in the reference reaction mixture.

A rejection under 35 U.S.C. § 103 must have a factual basis. The Mao reference does not provide any teaching or suggestion which would lead one skilled in the art to include a polyether triol in the disclosed polyether glycol component.
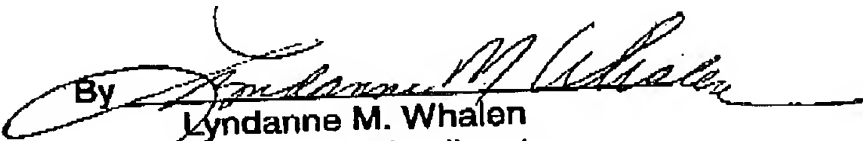
The teachings of Mao can not therefore be construed in any manner which would render Applicants' claimed invention obvious.

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Withdrawal of this rejection is therefore requested.

In view of the above remarks, reconsideration and allowance of Claims 11-22 are respectfully requested.

Respectfully submitted,

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Mo-6837   - 4 -

GRANT & HACKH'S
CHEMICAL
DICTIONARY

[American, International, European and British Usage]

*Containing the Words Generally Used in Chemistry,
and Many of the Terms Used in the Related
Sciences of Physics, Medicine, Engineering,
Biology, Pharmacy, Astrophysics,
Agriculture, Mineralogy, etc.*

Based on Recent Scientific Literature

FIFTH EDITION
Completely Revised and Edited by

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McGRAW-HILL BOOK COMPANY

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Hamburg Johannesburg London Madrid Mexico
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glutinic acid

glutinic acid HOOC·CH:C:CH·COOH = 128.1. 2,3-Pentadienedioic acid. White solid, m.146.

glutinosin $C_{48}H_{60}O_{16}(?)$. An antibiotic from the soil fungus *Metarrhizium glutinosum*; a severe skin irritant.

glutol A reaction product of starch and formaldehyde. Cf. *amyloform*.

Glutolin $C_{204}H_{336}N_{60}SO_{70}$. Trademark for formaldehyde gelatin. A protein derived from gelatin.

glutose The unfermentable reducing portion of cane molasses. A complex mixture of anhydrofructose; predominantly the compounds formed by the condensation of amino acids and their amides with simple sugars.

Gly* Symbol for glycine.

glycal A cyclic enol ether derivative of a sugar having a double bond between C atoms 1 and 2 of the ring.

glyceraldehyde* $CH_2OH·CHOH·CHO$ = 90.1. 2,3-Dihydroxypropanal*, glycerose. Colorless solid, m.132, soluble in water.

glycerals Compounds derived from glycerol and aldehydes, similar to the acetals.

glycerate* Glycerinate. A salt or ester of glyceric acid, containing the radical $C_3H_5O_4$—.

glyceric acid* $CH_2OH·CHOH·COOH$ = 106.1. 2,3-Dihydroxypropanoic acid*. Occurs as (+)- and (−)-acids. Colorless syrup, soluble in water, formed during alcoholic fermentation. 2-phenyl ~ Atroglyceric acid.

glyceric aldehyde Glyceraldehyde*.

glyceride An ether or ester derived from glycerol. The fats and oils are mainly triglycerides of fatty acids, e.g., palmitin.

glycerin(e) USP name for glycerol*. g. trinitrate Nitroglycerin.

glycerinate Glycerate*.

glycerino Glycero.

glycerinum Glycerol*.

glycero The radicals (1) 1,2,3-propanetriyl*; (2) —OH₂C·CHO·CH₂O=, from glycerol.

glycerogen A German wartime substitute for glycerol (glycerol 40, propylene glycol 40, other higher alcohols 20%). Made by hydrogenating inverted sucrose.

glycerol* $(CH_2OH)_2CHOH$ = 92.1. Glycerin(e), glycerinum, 1,2,3-propanetriol*, propenyl hydrate. Colorless, sweet syrup, (solidifies at lower temperature), b.290. soluble d.1.260, m.17 in water, insoluble in organic solvents. Obtained by the saponification of fats in the soap industry; used as a mordant, plasticizer, solvent, and reagent, in the manufacture of printer's ink and rolls, and explosives; also used for application to the skin and as suppositories (USP, EP, BP). absolute ~ G. free from water. diethyl ~ See *diethyl glycerol*. dithio ~ See *Dimercaprol*. mesitylene ~ Mesicerin. pentyl ~ $C_5H_9(OH)_3$. Trihydroxypentane. g. diacetate Diacetin. g. dinitrate Dinitroglycerol. g. diphenyl ether $C_{15}H_{16}O_3$ = 244.3. 1,3-Diphenoxy-2-propanol*. White crystals, m.80; a plasticizer for nitrocellulose. g. distearate Distearin. g. monochlorohydrin $C_3H_7O_2Cl$ = 110.5. alpha- ~ 3-Chloro-1,2-propanediol*. Colorless liquid, d.1.322, b₀.₅mm 81, miscible with water; used in the synthesis of 2,3-epoxy-1-propanol. beta- ~ 2-Chloro-1,3-dihydroxypropane; b₁₄mm 124. g. monophenyl ether $C_9H_{12}O_3$ = 168.2. 1-Phenoxy-2,3-propanediol*, autodyne. White solid m.53; a plasticizer. g. phosphoric acid $C_3H_5(OH)_2H_2PO_4$ = 172.1. An oily constituent of lecithins and nerve tissues. g. sulfuric acid $C_3H_5(OH)_2·HSO_4$. g. tributyrate Butyrin. g. trilaurate Laurin. g. trinitrate* Nitroglycerin. g. tripalmitate Palmitin. g. tristearate Stearin.

glycerolphosphate Lecithin. A salt of glycerolphosphoric acid containing the radical = $PO_4·C_3H_5(OH)_2$.

glycerophosphoric acid See *glycerophosphoric acid* under *glycerol*.

glycerose Glyceraldehyde°.

glycerosulfuric acid Glycerosulfuric acid.

glyceroyl° The radical $CH_2OH·CH(OH)·CO$—.

glyceryl The 1,2,3-propanetriyl* radical. g. aldehyde Glyceraldehyde*. g. chloride Trichlorohydrin. g. hydroxide Glycerol*. g. laurate Laurin. g. linoleate Trilinolein. g. monostearate $C_{20}H_{42}O_4$ = 346.5. A commercial emulsifying and dispersing agent, used mainly in cosmetics. A hard fat, containing 30–40% of the α isomer, m.54–60, dispersible in water. g. trinitrate Nitroglycerin.

glycide 2,3-Epoxy-1-propanol*.

glycidol 2,3-Epoxy-1-propanol*.

glycin (1) Glycine*. (2) p-Hydroxyphenylaminoacetic acid; a developer. (3) Mannitol. (4) Beryllium. (5) Glycyrrhiza.

glycine* $NH_2·CH_2·COOH$ = 75.1. Gly*, Glycocoll, aminoacetic acid (USP), aminoethanoic acid*. glycocin, gelatin sugar. Sweet, colorless, monoclinic crystals. d.1.575, m.232, slightly soluble in water. acetyl ~ See *acetylglycine*. amidinomethyl ~ Creatine. N-benzoyl ~ Hippuric acid*. carbamoyl ~ Hydantoic acid*. glycyl ~ The simplest peptide, $NH_2CH_2CONHCH_2COOH$. N-methyl ~ Sarcosine*. x-methyl ~ Alanine*. trimethyl ~ Betaine*. g. anhydride 2,5-Piperazinedione. g. betaine Betaine*.

glycinin The principal protein of the soybean.

glycinium* The cation $^+H_2N·CH_2·COOH$.

glycirrhiza Glycyrrhiza.

glyc(o)- (Greek: "sweet") Indicating sugars or glycine.

glycocholate A salt of glycocholic acid.

glycocholeic acid $C_{27}H_{45}O_5N$ = 463.7. A bile acid compound of glycogen and choleic acid. Colorless prisms. m.175, slightly soluble in hot water.

glycocholic acid $C_{26}H_{43}O_6N$ = 465.6. A bile acid compound of glycine and cholic acid. Colorless needles, m.134, soluble in water.

glycoclastic Glycolytic.

glycocoll Glycine*. g. betaine Betaine*.

glycogen $(C_6H_{10}O_5)_n$. Animal starch, glucogen, liver sugar. A stored carbohydrate in the animal organism, especially in the liver. Colorless, tasteless powder, readily hydrolyzed to glucose (red with iodine). Acids hydrolyze it to glucose, and enzymes to maltose. g. storage disease An inborn error of metabolism, in which g. hydrolysis cannot occur owing to a congenital deficiency of various enzymes.

glycogenase Amylase*.

glycogenesis The synthesis of glycogen from glucose, occurring in the liver and muscles.

glycogenolysis The successive breaking down of glycogen in animal tissues. Cf. *staircase reaction*.

glycol (1) See *glycols*. (2)* $CH_2OH·CH_2OH$ = 62.1. Ethylene g., 1,2-ethanediol, dihydroxyethane. Colorless liquid, d.1.115, b₂₀mm 198, miscible with water. An antifreeze (60% in water freezes at −49°C) and a solvent for cellulose esters; used to manufacture low-freezing dynamites. benzylene ~ Hydrobenzoin. butylene ~ Butanediol*. diethylene ~ Carbitol. diphenyl ~ Hydrobenzoin. ethylidene ~ MeCH(OH)₂. Known only in derivatives; as, acetals. mesitylene ~ See *mesicerin*. phenyl ~ Cinnamyl alcohol* propylene ~* 1,2-Propanediol*. tetramethylene ~ Butanediol*. tetramethylethylene ~ Pinacol*. tetraphenyl ~ Benzopinacol. trimethylene ~ 1,3-Propanediol*.
g. acetate See *ethylene monoacetate*, *ethylene diacetate* (both

under *ethylene*). g.aldehyde* $CH_2OH \cdot CHO$ = 60.0. Hydroxyaldehyde† glycolal, hydroxyethanal*. Colorless plates, m.96, soluble in water. g.amide $CH_2OH \cdot CONH_2$ = 75.1. 2-Hydroxyacetamide*. Colorless solid, m.120, soluble in water. g. bromohydria $CH_2OH \cdot CH_2Br$ = 125.0. Ethylene bromohydrin, 2-bromo-1-ethanol*. Colorless liquid, b.147, soluble in water. g. chlorohydrin $CH_2OH \cdot CH_2Cl$ = 80.5. Ethylene chlorohydrin, 2-chloro-1-ethanol*. Colorless liquid. b.128, miscible with water. g. cyanohydrin $CH_2OH \cdot CH_2CN$ = 71.1. Ethylene cyanohydrin. Colorless liquid, b.222, miscible with water. g. diacetate Ethylene diacetate*. g. dibromide Ethylene dibromide*. g. dichloride Ethylene dichloride*. g. dicyanide Ethylene dicyanide*. g. diiodide Ethylene diiodide*. g. dinitrate Ethylene dinitrate. g. dinitrite Ethylene dinitrite. g. ethers A group of compounds used as lacquer solvents; as, g. butyl ether (see *butyl Cellosolve* under *Cellosolve*). g. leucine Norleucine. g. monoacetate Ethylene monoacetate. g. mercaptan Ethylenethiol*. g. sulfhydrate Ethylenedithiol*. g. thiourea $C_3H_4ON_2S$ = 116.1. A solid, soluble in water, m.200 (decomp.).

glycolal Glycol aldehyde*.

glycoleucine Norleucine.

glycolic g. acid* $OHCH_2 \cdot COOH$ = 76.1. Glycollic acid. Hydroxyacetic acid†, hydroxyethanoic acid*. Colorless leaflets, m.78 (decomp.), soluble in water. diphenyl ~ Benzilic acid. phenyl ~ Mandelic acid.
g. aldehyde Glycol aldehyde*. g. amide Glycol amide. g. anhydride $(CH_2OH \cdot CO)_2O$ = 134.1, 1,4-Dioxane-2,5-dione. Colorless powder, m.129, insoluble in water.

glycolide $(-C(O) \cdot CH_2 \cdot O-)_2$ = 116.0. Glycollide. Colorless leaflets, m.86, soluble in alcohol.

glycolipids Fatty substances, yielding on hydrolysis fatty acids and a carbohydrate, usually glucose. They contain no phosphorus; e.g., kerasin.

glycoloyl* Hydroxyacetyl†, glycolyl. The radical $OH \cdot CH_2 \cdot CO-$

glycols Diols. *Term formally used for dihydric alcohols. Now limited to ethylene and propylene glycol.

glycolyl The glycoloyl* radical.

glycolysis Glycolytic or Embden-Meyerhof pathway. The decomposition of glucose into pyruvic acid (pyruvate) by enzymes: the energy source of animals and anaerobic organisms.

glycolytic See *glycolysis*.

glycophospholipids Fatty substances which yield a fatty acid, a carbohydrate, and phosphoric acid on hydrolysis.

glycoproteins Glucoproteins. Conjugated proteins containing a carbohydrate radical and a simple protein; e.g., ichthulin.

Glycosal Trademark for glycerol salicylate.

glycosamine $C_6H_{11}O_5NH_2$ = 179.2. A decomposition product of chitin. Colorless crystals, slightly soluble in water.

glycoside A natural compound of a sugar with another substance, which hydrolyzes to a sugar plus a principle; (e.g., coniferin yields glucose plus coniferyl alcohol as the principle); *glucosides* yield glucose, *fructosides* yield fructose, *galactosides* yield galactose, etc. Many pigments (as anthocyanins), saponins, and tannins are glycosides. Examples (parent compound in parentheses): sinigrin (ethylene), arbutin (benzene), daphnin (styrene), quercitrin (flavone, anthoxanthin), cyanin (anthocyanins), frangulin (anthracene), prulaurasin (cyanogen), indican (indoxyl). digitalin (cholane).

glycosidic bond The ether linkage between monosaccharide units of a polysaccharide; as, $\alpha(1,4)$ or $\beta(1,6)$, the numbers indicating the participating C atoms.

glycosuria Sugar in the urine. Usually due to diabetes, but may be physiological or due to some drugs.

glycotropin A hormone resembling *prolactin*, q.v.

glycuronate A salt of glucuronic acid.

glycuronic acids Uronic acids.

glycyl* Aminoacetyl†. The radical $NH_2 \cdot CH_2CO-$, from glycine. It occurs in peptides, e.g., glycylalanine.

glycyrrhetinic acid $C_{30}H_{46}O_4$ = 470.7. m.302. Aglycone from licorice root.

glycyrrhiza (1) Licorice. The dried, aqueous extract of licorice root. Lustrous, black, brittle mass, soluble in water (BP). (2) The rhizome and roots of *Glycyrrhiza glabra typicat*. Spanish licorice, and *C. glabra glandulifera*, Russian licorice (Leguminosae). A flavoring in medicines (NF).

glycyrrhizic acid $C_{44}H_{64}O_{19}N$ = 911.0. Crystals, m.220, from licorice.

glycyrrhizin $C_{44}H_{64}O_{20}$ (?). A glucoside of glycyrrhetinic acid. Brown scales, m.205 (decomp.), soluble in water; optically inactive.

glyoxal* $(CHO)_2$ = 58.0. Oxalaldehyde, ethanedial*, diformyl, oxal. Colorless, deliquescent powder or liquid, d.1.14, m.15, b.50, soluble in water. difuryl ~ Furil*. dimethyl ~ Biacetyl*. diphenyl ~ Benzil*. methyl ~ Pyruvaldehyde*. phenyl ~ Benzoyl formaldehyde. poly ~, trimeric ~ $C_{12}H_{18}O_6$ = 290.3. A threefold polymer of g., known as its acetone derivative.

glyoxalase An enzyme in all animal tissues, except pancreas and lymph glands. It converts glyoxal or its substituents (as, R is Me) into glycolic acid or its substituents;

$$R \cdot CO \cdot CHO + H_2O = R \cdot CHOHCOOH$$

glyoxalene Imidazole*.

glyoxalic acid $CHO \cdot COOH$ = 74.0. Ethanol acid, oxoethanoic acid*, oxaldehydic acid. Colorless rhombs, soluble in water, forming $(HO)_2CH \cdot COOH$. Cf. *glyoxylic acid*. amino ~ Oxamic acid*. aminophenyl ~ Isatic acid. carboxyphenyl ~ o-~ Phthalonic acid. p-~ Terephthalic acid. methyl ~ Pyruvic acid*. phenyl ~ Benzoylformic acid.
g. a. hydrate Glyoxylic acid*.

glyoxaline Imidazole*.

glyoxime $(CH:NOH)_2$ = 88.1. Colorless prisms, m.178, soluble in water. Cf. *dimethylglyoxime* (under *dimethyl*), *Tschugajew's reaction*.

glyoxyl Glyoxyloyl*.

glyoxylic acid* $(HO)_2CHCOOH$ = 92.1. Dihydroxyacetic acid*. The hydrated and crystalline form of *glyoxalic acid*, q.v.; in unripe fruit.

glyoxyloyl* The radical $OHC \cdot CO-$, from glyoxylic acid.

glyphosate* See *herbicides*, Table 42 on p. 281.

Glyptal Trademark for synthetic resins and plasticizers prepared from a polyhydric alcohol and phthalic anhydride.

gm Abbreviation for gram. Correct usage is g.

Gmelin G., Christian Gottlieb (1792-1860) German chemist, noted for making artificial ultramarine. G., Johann Friedrich (1748-1804) German physician and writer on chemistry. G., Leopold (1788-1853) German chemist, noted as discoverer of potassium hexacyanoferrate(II). A prolific author. G. test Nitric acid is dropped on filter paper saturated with urine; concentric rings of various colors appear in presence of bile acids.

gmelinite $(Ca,Na_2)Al_2Si_3O_{12}$. A native chabazite.

gneiss Crystalline metamorphic rocks; typically of quartz or feldspar.

gnoscopine $C_{22}H_{23}O_7N$ = 413.4. $(\pm)$-Narcotine. An opium alkaloid, m.229, in the mother liquor of narceine; synthesized

UDC 614.897.2.

Requirements and test methods for safety, protective and occupational footwear for professional use
English version of DIN EN 344

DIN

EN 344

This standard supersedes DIN 32 768, July 1990 edition, and, together with DIN 345, January 1993 edition, will supersede DIN 4843, December 1988 edition (cf. Start of validity).

Anforderungen und Prüfverfahren für Sicherheits-, Schutz- und Berufsschuhe für den gewerblichen Gebrauch

European Standard EN 344 : 1992 has the status of a DIN Standard.

A comma is used as the decimal marker.

This standard includes safety requirements within the meaning of the *Gerätesicherheitsgesetz* (Equipment Safety Law).

Start of validity
This standard is valid from 1 January 1993. However, in accordance with article 10 of the 8th Regulation pertaining to the *Gerätesicherheitsgesetz*, it shall be permitted to vend, until 31 December 1994, safety footwear which has been manufactured in compliance with the December 1988 edition of DIN 4843 and the July 1990 edition of DIN 32 768.

National foreword
This standard has been prepared by CEN/TC 161.
The responsible German body involved in its preparation was the *Normenausschuß Persönliche Schutzausrüstung* (Personal Protective Equipment Standards Committee).
DIN EN 344 specifies general requirements and methods of test for safety, protective, and occupational footwear for professional use. More specific requirements (e.g. those relating to the level of risk involved) are given in DIN EN 345 through DIN EN 347.
The members of CEN/TC 161 were not able to reach agreement on the incorporation of some of the specifications given in the Council Directive of 21 December 1989 on the approximation of the laws of the Member States relating to personal protective equipment (89/686), particularly for the footwear required in mining, agriculture, forestry and fire-fighting, and that subject to more stringent requirements regarding skid-resistance.
Determining whether footwear have a certain degree of skid resistance requires that objective assessment criteria (e.g. test methods) be available; however, interlaboratory testing conducted at the international level has given widely diverging results. Therefore, no agreement could be reached within CEN/TC 161 on a test method for determining this property (which was to be included in DIN EN 344), and a working group was formed for this purpose. Until such time as a European test method is developed, the specifications given in DIN 4843 Part 100 will continue to be used in Germany for determining and testing the skid resistance of safety footwear.

Standard referred to
(and not included in Normative references)
DIN 4843 Part 100   Safety footwear; skid-resistant footwear; safety requirements and testing

Previous editions
DIN 23 301: 06.51,11.55xx,11.66
DIN 23 302: 10.53,03.56x,04.63
DIN 23 312: 09.53,03.56x
DIN 23 321: 10.58
DIN 23 322: 09.57

DIN 4843 Part 1: 10.75
DIN 4843 Part 2: 10.75
DIN 4843 Part 3: 11.75
DIN 4843 Part 4: 11.75
DIN 4843: 07.68,08.85,12.88
DIN 32 768: 08.85,07.90

Continued overleaf.
EN comprises 86 pages.

DIN EN 344   Engl.   Price

Page 2   DIN EN 344

Amendments

The specifications of DIN 4843, December 1988 edition, have been revised and are now included in DIN EN 344 and DIN EN 345, those of DIN 32 768, July 1990 edition, also having been revised and included in the present standard.

International Patent Classification

A 43 B 007/32
G 01 N 003/00
G 01 N 019/00
G 01 N 017/02

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 344

November 1992

UDC 614.897.2 : 687.157 : 620.1

Descriptors: Personal protective equipment, accident prevention, work safety, footwear, boots, specifications, characteristics, tests.

English version

Requirements and test methods for safety, protective and occupational footwear for professional use

Exigences et méthodes d'essai des
chaussures de sécurité, des chaussures
de protection, et des chaussures de
travail à usage professionnel

Anforderungen und Prüfverfahren für
Sicherheits-, Schutz- und Berufsschuhe
für den gewerblichen Gebrauch

This European Standard was approved by CEN on 1992-10-30.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 344 : 1992 E

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Foreword

This European Standard was prepared by Technical Committee CEN/TC 161 'Foot and leg protectors', the Secretariat of which is held by BSI.

This European Standard has been prepared under a mandate given to CEN by the Commission of the European Communities and the European Trade Association, and supports essential requirements of the EC Directive(s).

Work on this standard was initiated by Technical Committee CEN/TC 161 at its inaugural meeting in April 1989 and was subsequently undertaken by Technical Committee CEN/TC 161/WG 1. A draft proposal was prepared and circulated for the CEN Enquiry in 1990. Following consideration of all the comments received, a revised draft was prepared and agreement for its submission to the formal vote was given in October 1991. The result of the formal vote was positive.

This European Standard relates directly to EN 345:1992, EN 346:1992 and EN 347:1992, which specify requirements for footwear for different areas of work.

Further requirements and test methods for safety, protective and occupational footwear are currently being developed by Technical Committee CEN/TC 161. Initially, these will be published separately, but eventually it is intended that they should be incorporated in one standard.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 1993, and conflicting national standards shall be withdrawn at the latest by May 1993.

The Standard was approved and in accordance with the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

1 Scope

This European Standard specifies requirements and, where appropriate, test methods to establish conformity with these requirements for footwear intended to protect the wearer's feet and legs against foreseeable hazards in a variety of working sectors.

This standard can be used only in conjunction with EN 345 : 1992, EN 346 : 1992 or EN 347 : 1992, which give requirements for footwear relating to specific levels of risk.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 345 : 1992	Specification for safety footwear for professional use
EN 346 : 1992	Specification for protective footwear for professional use
EN 347 : 1992	Specification for occupational footwear for professional use
ISO 34 : 1979	Rubber, vulcanized - Determination of tear strength (trouser, angle and crescent test pieces)
ISO 1817 : 1985	Rubber, vulcanized - Determination of the effect of liquids
ISO 2023 : 1973	Lined industrial rubber footwear
ISO 2286 : 1986	Rubber - or plastics-coated fabrics - Determination of roll characteristics
ISO 2589 : 1972	Leather - Physical testing - Measurement of thickness
ISO 3290 : 1975	Rolling bearings - Bearing parts - Balls for rolling bearings
ISO 3376 : 1976	Leather - Determination of tensile strength and elongation
ISO 3377 : 1975	Leather - Determination of tearing load
ISO 4045 : 1977	Leather - Determination of pH
ISO 4593 : 1979	Plastics - Film and sheeting - Determination of thickness by mechanical scanning
ISO 4643 : 1992	Moulded plastics footwear - Lined or unlined poly(vinyl chloride) boots for general industrial use - Specification
ISO 4648 : 1991	Rubber, vulcanized or thermoplastic - Determination of dimensions of test pieces and products for test purposes

ISO 4649 : 1985   Rubber – Determination of abrasion resistance using a rotating cylindrical drum device

ISO 4674 : 1977   Fabrics coated with rubber or plastics – Determination of tear resistance

ISO 5084 : 1977   Textiles – Determination of thickness of woven and knitted fabrics (other than textile floor coverings)

ISO 5423 : 1992   Moulded plastics footwear – Lined or unlined polyurethane boots for general industrial use – Specification.

3 Definitions

NOTE: The component parts of footwear are illustrated in figures 1 and 2.

For the purposes of this standard, the following definitions apply.

3.1 safety footwear for professional use: Footwear incorporating protective features to protect the wearer from injuries which could arise through accidents in the working sectors for which the footwear was designed, fitted with toecaps designed to give protection against impact when tested at an energy level of 200 J.

3.2 protective footwear for professional use: Footwear incorporating protective features to protect the wearer from injuries which could arise through accidents in the working sectors for which the footwear was designed, fitted with toecaps designed to give protection against impact when tested at an energy level of 100 J.

3.3 occupational footwear for professional use: Footwear incorporating protective features to protect the wearer from injuries which could arise through accidents in the working sectors for which the footwear was designed.

3.4 leather: This term covers

full grain leather: Hide or skin tanned to be imputrescible with its original fibrous structure more or less intact and still possessing the full grain layer.

corrected grain leather: Hide or skin tanned to be imputrescible with its original fibrous structure more or less intact, but which has been subjected to mechanical buffing to modify its grain structure.

leather split: Flesh or middle part of a skin or hide tanned to be imputrescible with its original fibrous structure more or less intact and split or shaved to eliminate completely the grain layer.

3.5 rubber: Vulcanized elastomers.

3.6 polymeric materials: Materials made of polyurethane, polyvinylchloride or thermoplastic rubber.

3.7 height of the upper: Vertical distance between the top surface of the extreme rear edge of the insole and the highest point of the back of the upper.

3.8 insole: Non-removable bottom inside component of the footwear adjacent to the foot.

3.9 lining: Inside layer of the upper which is adjacent to the foot.

3.10 fuel oil: Aliphatic hydrocarbon constituent of petroleum.

Figure 1: Parts of footwear

Upper

Safety or protective toe cap

Upper

Rigid sole

Reinforcing welt
with nails

Outsole

Wooden sole

Upper

Rigid sole
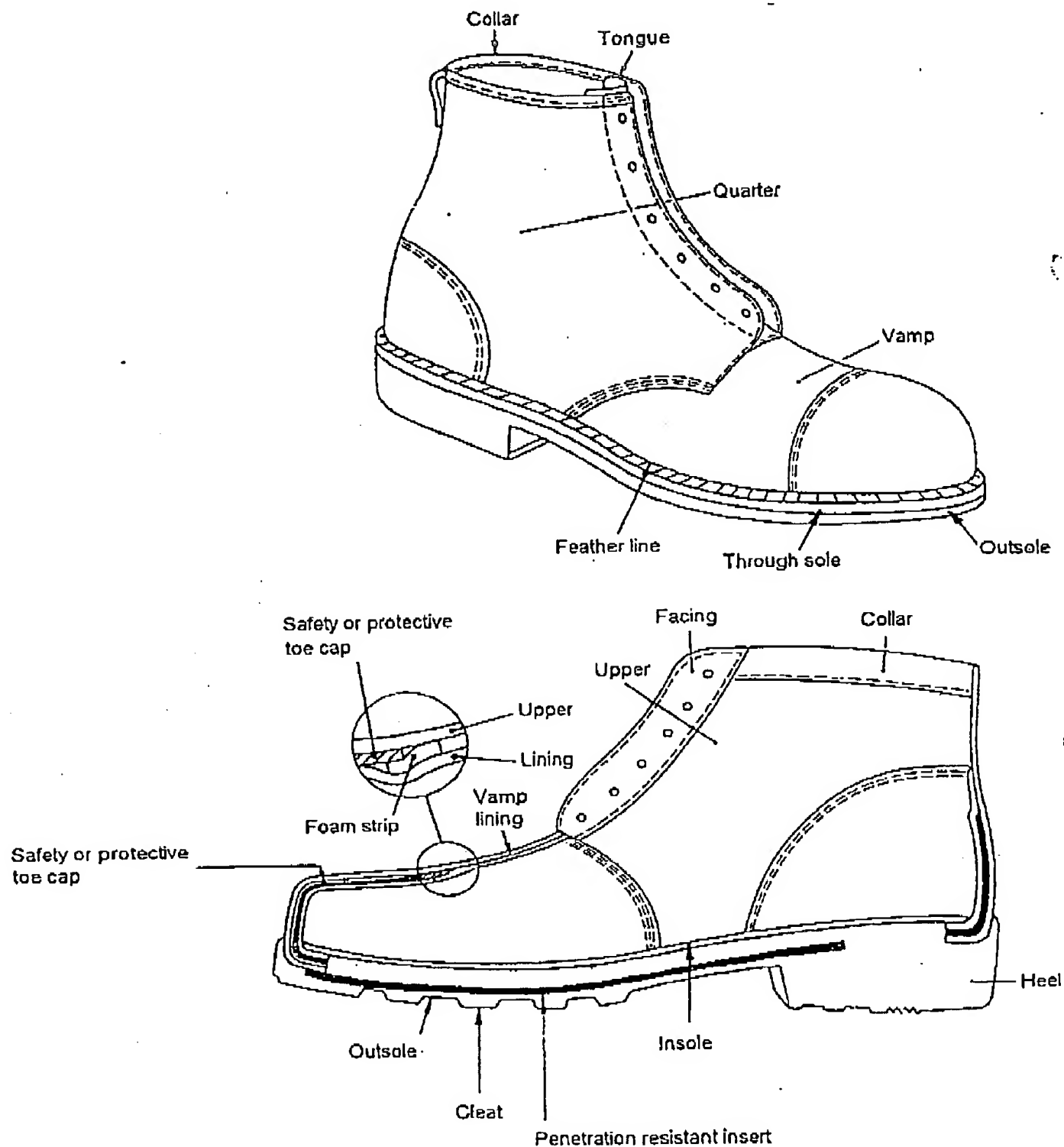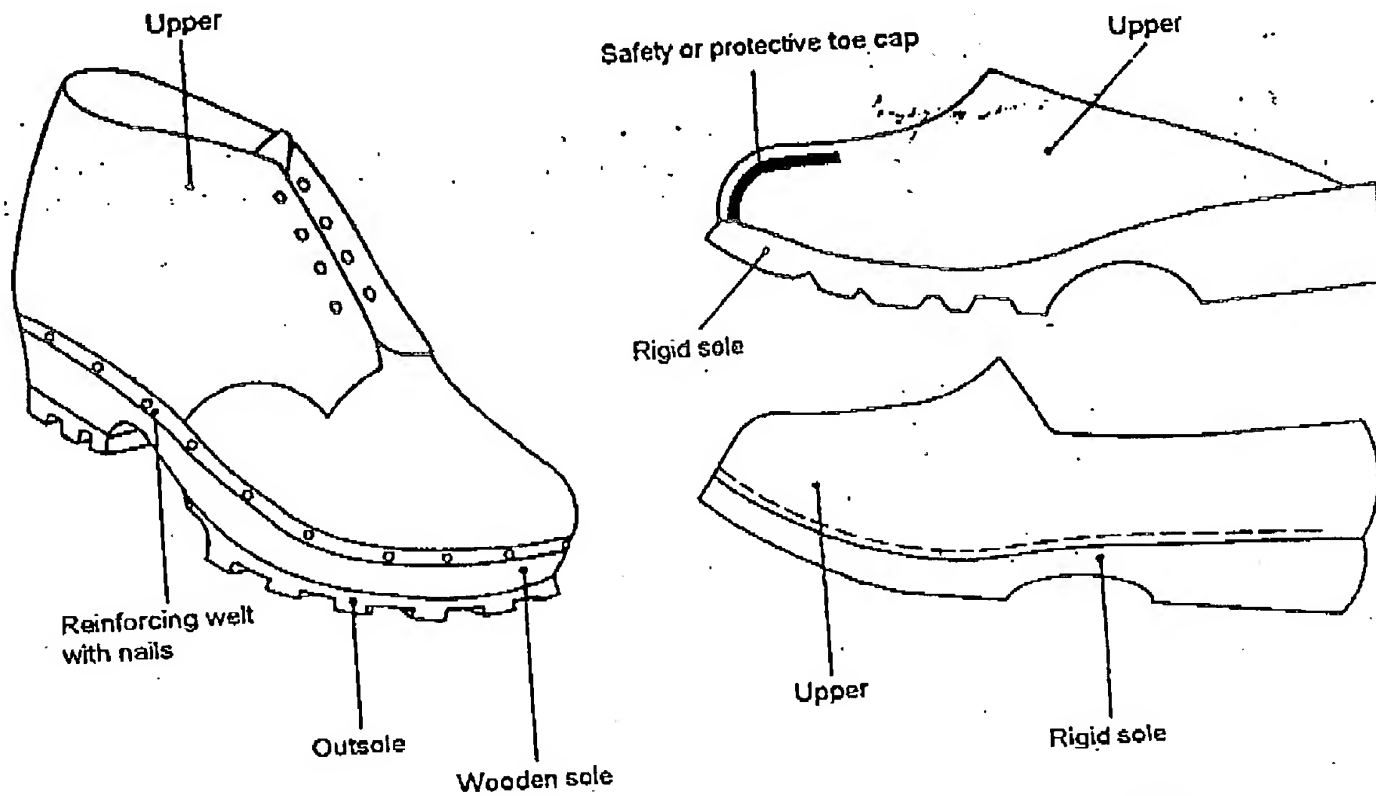
Figure 1: Parts of footwear (continued)

Upper

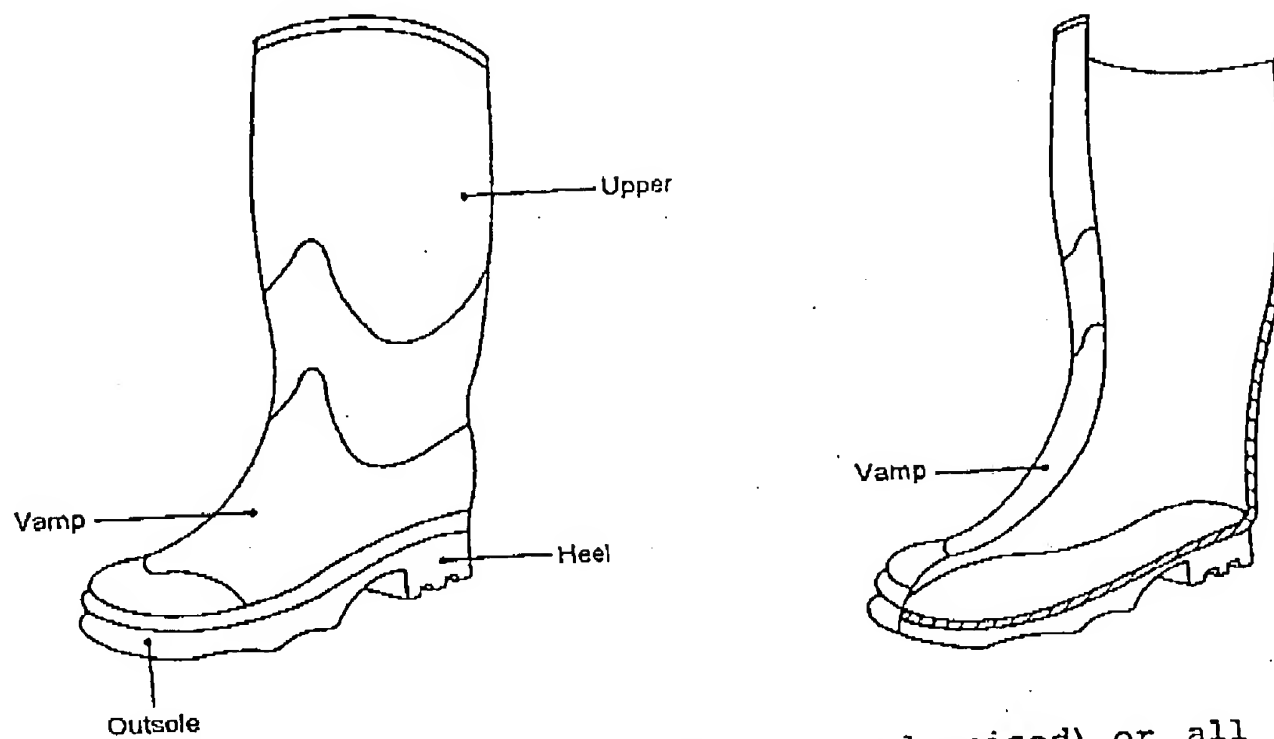Vamp

Heel

Vamp

Outsole

**Figure 2: Parts of all-rubber (i.e. vulcanized) or all
polymeric (i.e. entirely moulded) footwear**

4   Requirements

4.1   Sampling and conditioning

The minimum number of samples, i.e. separate items of footwear, to be tested in order to check compliance with the requirements specified in clause 4, together with the minimum number of test pieces taken from each sample, shall be as given in table 1.

Wherever possible, test pieces shall be taken from the whole footwear.

> NOTE: If it is not possible to obtain a large enough test piece from the footwear, then a sample of the material from which the component has been manufactured may be used instead and this should be noted in the test report.

Where samples are required from each of three sizes, these shall comprise the largest, smallest and a middle size of the footwear under test.

All test pieces shall be conditioned in a standard atmosphere of 20 °C ± 2 °C and 65 % ± 2 % r.h. for a minimum of 48 h before testing, unless otherwise stated in the test method.

The maximum time which shall elapse between removal from the conditioning atmosphere and the start of testing shall be not greater than 10 min, unless otherwise stated in the test method.

Each test piece shall individually satisfy the specified requirement, unless otherwise stated in the test method.

Table 1: Minimum number of samples and test specimens or test pieces

Requirement	Clause reference	Number of samples	Number of test pieces from each sample
Upper/outsole and sole interlayer bond strength	4.3.1.2 4.8.7	1 from each of 3 sizes	1
Internal toecap length	4.3.2.2	1 pair from each of 3 sizes	1 pair
Impact resistance	4.3.2.3.1 4.3.2.3.2	1 pair from each of 3 sizes	1 pair
Compression resistance	4.3.2.4.1 4.3.2.4.2	1 pair from each of 3 sizes	1 pair
Corrosion resistance of metal toecaps or metal penetration resistant inserts	4.3.2.5 4.3.3.2.3	2	1
Penetration resistance	4.3.3.1	1 pair from each of 3 sizes	1 pair
Dimensions of penetration resistant inserts	4.3.3.2.2	1 pair from each of 3 sizes	1 pair
Electrical resistance	4.3.4	1 pair from each of 3 sizes	1 pair
Insulation against heat	4.3.5.1	2	1
Insulation against cold	4.3.5.2	2	1
Energy absorption of seat region	4.3.6	1 pair from each of 3 sizes	1 pair
Leakproofness	4.3.7	2	1
Thickness	4.4.1 4.5.1	1 from each of 3 sizes	3

Table 1: (continued)

Requirement	Clause reference	Number of samples	Number of test pieces from each sample
Tear strength	4.4.2 4.5.2 4.6.1 4.8.3	1 from each of 3 sizes	3
Tensile properties	4.4.3	1 from each of 3 sizes	3
Flexing resistance	4.4.4	1 from each of 3 sizes	1
Water penetration and water absorption	4.4.5	1 from each of 3 sizes	1
Water vapour permeability and coefficient	4.4.6 4.5.4	1 from each of 3 sizes	1
pH value	4.4.7 4.5.5 4.6.2 4.7.2	1 from each of 3 sizes	1
Hydrolysis	4.4.8 4.8.6	1 from each of 3 sizes	1
Abrasion resistance of lining	4.5.3	1 from each of 3 sizes	4
Thickness of insole	4.7.1	1 from each of 3 sizes	1
Water absorption and desorption of insole	4.7.3	1 from each of 3 sizes	1
Abrasion resistance of insole	4.7.4	1 from each of 3 sizes	1
Thickness of outsole	4.8.1 4.8.2	1 from each of 3 sizes	1

Table 1: (concluded)

Requirement	Clause reference	Number of samples	Number of test pieces from each sample
Abrasion resistance of outsole	4.8.4	1 from each of 3 sizes	1
Flexing resistance of outsole	4.8.5	1 from each of 3 sizes	1
Resistance to hot contact	4.8.8	1 from each of 3 sizes	1
Resistance to fuel oil	4.8.9	1 from each of 3 sizes	1

4.2 Design

NOTE: The designs of footwear covered by this standard are illustrated in figure 3.
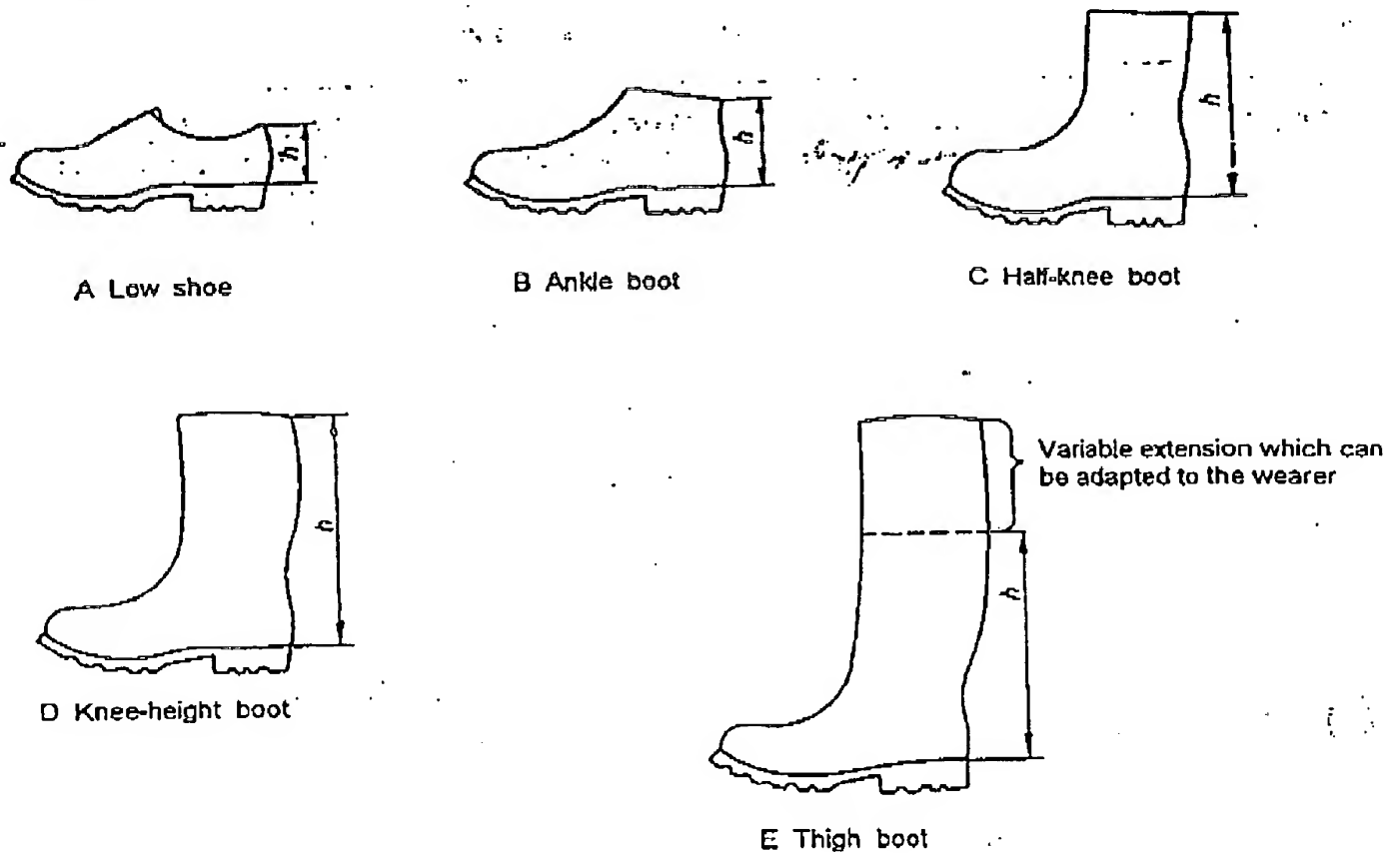
4.2.1 Height of upper

The height of the upper (h) shall be as given in table 2.

Table 2: Height of upper

Footwear size		Height, h			
Paris points	English	Design A mm	Design B mm min.	Design C mm min.	Design D mm min.
36 and below	3 and below	< 103	103	162	255
37 and 38	4 and 5	< 105	105	165	260
39 and 40	6	< 109	109	172	270
41 and 42	7 and 8	< 113	113	178	280
43 and 44	9 and 10	< 117	117	185	290
45 and above	11 and above	< 121	121	192	300

4.2.2 Seat region

The seat region shall be closed.

A Low shoe   B Ankle boot   C Half-knee boot

D Knee-height boot

Variable extension which can
be adapted to the wearer

E Thigh boot

Note: Design E is a knee-height boot (design D) equipped
with a thin impermeable material which extends the upper
and which can be cut to adapt the boot to the wearer.

Figure 3: Designs of footwear

4.3 Whole footwear

4.3.1 Sole performance

4.3.1.1 Construction

Unless the footwear has a rigid sole, an insole shall be present in
such a way that it cannot be removed without damaging the footwear.

4.3.1.2 Upper/outsole bond strength

When footwear, other than that with a rigid sole, is tested in
accordance with the method described in 5.1, the bond strength shall
be not less than 4,0 N/mm.

4.3.2 Toe protection

4.3.2.1 General

Safety or protective toecaps shall be incorporated in the footwear in such a manner that they cannot be removed without damaging it.

With the exception of all-rubber and all-polymeric footwear, footwear fitted with internal toecaps shall have a vamp lining or an element of the upper that serves as a lining, and in addition the toecaps shall have an edge covering extending from the back edge of the toecap to at least 5 mm beneath it and at least 10 mm in the opposite direction.

Scuff resistant coverings for the toe region shall be not less than 1 mm in thickness.

> NOTE: Recommendations for the assessment of toecaps to be used in safety or protective footwear are given in annex A.

4.3.2.2 Internal length of toecaps

When measured in accordance with the method described in 5.2, the internal toecap length shall be not less than the appropriate value given in table 3.

Table 3: Minimum internal length of toecaps

Size of footwear		Minimum internal length mm
Paris points	English	
36 and below	3 and below	34
37 and 38	4 and 5	36
39 and 40	6	38
41 and 42	7 and 8	39
43 and 44	9 and 10	40
45 and above	11 and above	42

4.3.2.3 Impact resistance

4.3.2.3.1 Impact resistance of safety footwear

When safety footwear is tested in accordance with the method described in 5.3 at
an energy level of 200 J ± 4 J, the clearance under the toecap at the moment of
impact shall be not less than the appropriate value given in table 4. In
addition, the toecap shall not develop any cracks on the test axis which go
through the material, i.e. through which light can be seen.

Table 4: Minimum clearance under toecaps at impact

Size of footwear		Minimum clearance mm
Paris points	English	
36 and below	3 and below	12,5
37 and 38	4 and 5	13,0
39 and 40	6	13,5
41 and 42	7 and 8	14,0
43 and 44	9 and 10	14,5
45 and above	11 and above	15,0

4.3.2.3.2 Impact resistance of protective footwear

When protective footwear is tested in accordance with the method described in 5.3 at an energy level of 100 J ± 2 J, the clearance under the toecap at the moment of impact shall be not less than the appropriate value given in table 4. In addition the toecap shall not develop any cracks on the test axis which go through the material, i.e. through which light can be seen.

4.3.2.4 Compression resistance

4.3.2.4.1 Compression resistance of safety footwear

When safety footwear is tested in accordance with the method described in 5.4, the clearance under the toecap at a compression load of 15 kN ± 0,1 kN shall be not less than the appropriate value given in table 4.

4.3.2.4.2 Compression resistance of protective footwear

When protective footwear is tested in accordance with the method described in 5.4, the clearance under the tocap at a compression load of 10 kN ± 0,1 kN shall be not less than the appropriate value given in table 4.

4.3.2.5 Corrosion resistance of metal toecaps in all-rubber footwear

When all-rubber footwear is tested and assessed in accordance with the method described in 5.5, the toecap shall exhibit no more than five areas of corrosion, none of which shall exceed 2,5 mm^2 in area.

> NOTE: This test is applied only to all-rubber footwear because the toecaps are bonded directly to the rubber during the manufacturing process and they cannot therefore be pre-treated with a protective coating. Toecaps intended for use in other types of safety and protective footwear are coated to protect them against corrosion (see also A.1.2).

4.3.3 Penetration resistance

4.3.3.1 All penetration resistant footwear

When footwear is tested in accordance with the method described in 5.6 the force required to penetrate the sole unit shall be not less than 1100 N.

4.3.3.2 Additional requirements for footwear which incorporates penetration resistant inserts

> NOTE: Recommendations for further tests which may be used to assess the suitability of penetration resistant inserts before they are incorporated in footwear are given in annex B.

4.3.3.2.1 Construction The penetration resistant insert shall be built into the bottom of the shoe in such a manner that it cannot be removed without damaging the footwear.

The insert shall not lie above the flange of the safety or protective toecap and shall not be attached to it.

4.3.3.2.2 Dimensions The penetration resistant insert shall be of such a size that with the exception of the heel region, the maximum distance between the line represented by the feather edge of the last and the edge of the insert is 6,5 mm. In the heel region the maximum distance between the line represented by the feather edge of the last and the insert shall be 17 mm. (See figure 4).

The penetration resistant insert shall have no more than three holes of maximum diameter 3 mm to attach it to the bottom of the footwear. The holes shall not lie in the shaded area shown in figure 4.

4.3.3.2.3 Corrosion resistance of metal penetration resistant inserts in all-rubber footwear When all-rubber footwear is tested and assessed in accordance with the method described in 5.5 the penetration resistant insert shall exhibit no more than five areas of corrosion, none of which shall exceed 2,5 mm² in area. (See note to 4.3.2.5 and also B.1.3).

Dimensions in mm
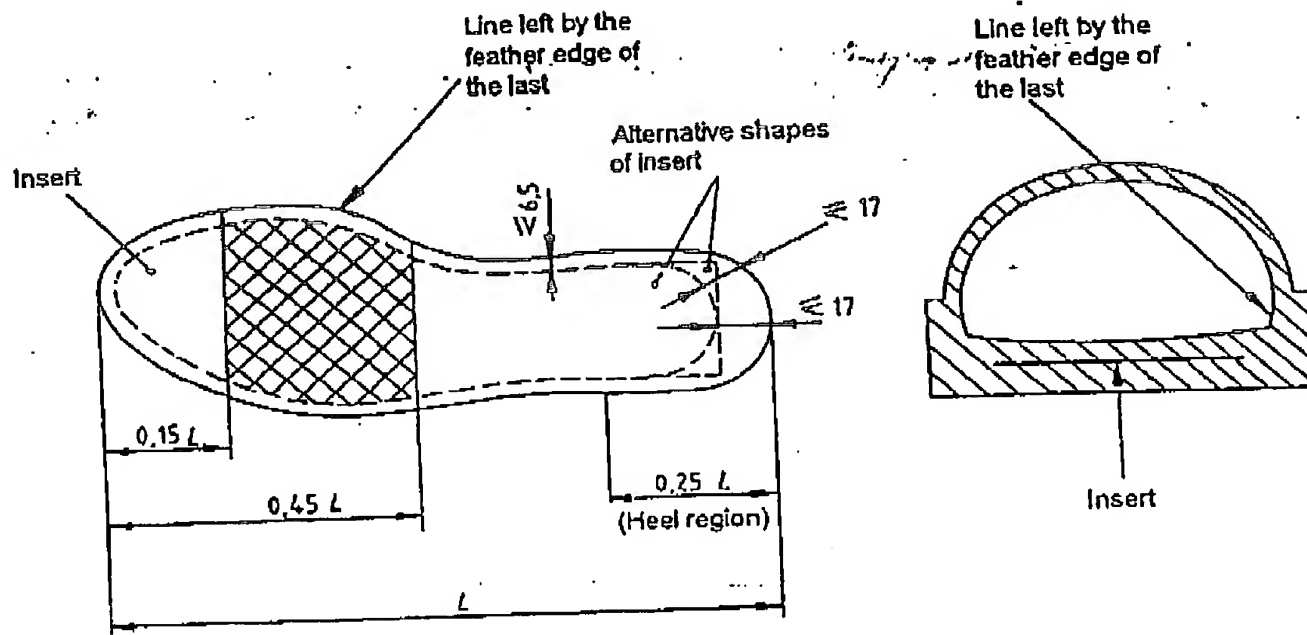
L = The length of the inside of the bottom of the footwear

Figure 4: Position of penetration
resistant insert

4.3.4 Electrical resistance

4.3.4.1 Conductive footwear

When measured in accordance with the method described in 5.7 after conditioning in a dry atmosphere (5.7.2.3 a)), the electrical resistance shall be not greater than 100 kΩ.

4.3.4.2 Antistatic footwear

When measured in accordance with the method described in 5.7, after conditioning in a dry and wet atmosphere (5.7.2.3 a) and b)), the electrical resistance shall be not less than 100 kΩ and not greater than 1 000 MΩ.

4.3.5 Resistance to inimical environments

4.3.5.1 Heat insulation of sole complex

When footwear is tested in accordance with the method described in 5.8 the temperature increase on the upper surface of the insole shall be not greater than 22 °C.

The insulation shall be incorporated in the footwear in such a manner that it cannot be removed without damaging the bottom of the footwear.

4.3.5.2 Cold insulation of sole complex

When footwear is tested in accordance with the method described in 5.9, the temperature decrease on the upper surface of the insole shall be not more than 10 °C.

The insulation shall be incorporated in the footwear in such a manner that it cannot be removed without damaging the bottom of the footwear.

4.3.6 Energy absorption of seat region

When footwear is tested in accordance with the method described in 5.10 the energy absorption of the seat region shall be not less than 20 J.

4.3.7 Leakproofness

When tested in accordance with the method described in 5.11 there shall be no leakage of air.

4.4 Upper

NOTE 1: The requirements specified for uppers do not apply to the extension of the upper indicated for design E (see figure 3).

NOTE 2: The textile layer in all-rubber and all-polymeric footwear is a part of the upper and should not be removed.

4.4.1 Thickness

When determined in accordance with the appropriate method, the thickness of the upper at any point shall be not less than the value given in table 5.

NOTE: The thickness of the upper should include the textile layer.

Table 5: Minimum thickness of upper

Type of material	Test method	Minimum thickness mm
Rubber	ISO 4648 : 1991*	1,50
Polymeric	ISO 4593 : 1979	1,00
* Using a thickness gauge with a flat presser foot of 10 mm diameter and a load of 1 N.		

4.4.2 Tear strength

When determined in accordance with the appropriate method, the tear strength of the upper shall be not less than the value given in table 6, with the exception of non-leather uppers required to have particular resistance to animal fats, when the minimum tear strength shall be 30 N.

Table 6: Minimum tear strength of upper

Type of material	Test method	Minimum force N
Leather	ISO 3377 : 1975	120
Coated fabric and textile	A.2* of ISO 4674 : 1977	60
* Using a rectangular test piece 50 mm x 25 mm with a cut 20 mm long placed centrally and parallel with the longer sides to form a trouser tear test piece. Carry out the test at a constant rate of traverse of 100 mm/min.		

4.4.3 Tensile properties

When determined in accordance with the appropriate method, the tensile properties shall be as given in table 7.

Table 7: Tensile properties

Type of material	Test method	Tensile property	Value
Leather split	ISO 3376 : 1976*	Tensile strength	15 N/mm² minimum
Rubber	Annex A of ISO 2023 : 1973	Breaking force	180 N minimum
Polymeric	ISO 4643 : 1992	Modulus at 100 % elongation	1,3 MPa to 4,6 MPa
		Elongation at break	250 % minimum

* Using the test piece l = 90 mm, b_1 = 25 mm.

4.4.4 Flexing resistance

When tested in accordance with the appropriate method, the upper shall withstand not less than the number of continuous flexes given in table 8 without cracking.

Table 8: Minimum number of flexes

Type of material	Test method	Minimum number of flexes
Rubber	Annex B of ISO 2023 : 1973	125 000
Polymeric	Annex B* of ISO 4643 : 1992	150 000

* Test carried out at – 5 °C.

4.4.5 Water penetration and water absorption

When tested in accordance with the method described in 5.12, the water absorption shall be not higher than 30 % after 60 min from the start of the test and water penetration shall not occur during this period; nor exceed 2 g after a further 30 min.

4.4.6 Water vapour permeability and coefficient

When tested in accordance with the methods described in 5.13, the water vapour permeability shall be not less than 0,8 mg/(cm² · h), and the water vapour coefficient shall be not less than 20 mg/cm².

4.4.7 pH value

When leather uppers are tested in accordance with the method described in ISO 4045 : 1977, the pH value shall be not less than 3,5 and if the pH is below 4 the difference figure shall be less than 0,7.

4.4.8 Hydrolysis

When polyurethane uppers are tested in accordance with the method described in annex B of ISO 5423 : 1992 after being prepared and conditioned as described in annex E of that standard, no cracking shall occur before 150 000 flex cycles. Conditioning at ambient temperature shall be carried out at 20 °C ± 2 °C.

4.5 Lining

NOTE:- The textile layer in all-rubber and all-polymeric footwear is a part of the upper and should not be tested.

4.5.1 Thickness

When determined in accordance with the appropriate method, the thickness of the lining shall be not less than the value given in table 9.

Table 9: Minimum thickness of lining

Type of material	Test method	Minimum thickness mm
Leather	ISO 2589 : 1972	0,8
Coated fabric	ISO 2286 : 1986*	0,8
Textile	ISO 5084 : 1977*	0,8

* Using a thickness gauge with a flat presser foot of diameter 10 mm exerting a pressure of 2 kPa.

4.5.2 Tear strength

When determined in accordance with the appropriate method, the tear strength of the lining shall be not less than the value given in table 10.

Table 10: Minimum tear strength of lining

Type of material	Test method	Minimum force N
Leather	ISO 3377 : 1975	30
Coated fabric and textile	A.2* of ISO 4674 : 1977	15

* See table 6 for test conditions.

4.5.3 Abrasion resistance

When tested in accordance with the method described in 5.14, the wearing surface of textile linings shall not develop any holes before the following number of cycles has been performed:

- dry   25 600 cycles;
- wet   12 800 cycles.

4.5.4 Water vapour permeability and coefficient

When tested in accordance with the methods described in 5.13, the water vapour permeability shall be not less than 2,0 mg/(cm^2·h) and the water vapour coefficient shall be not less than 30 mg/cm^2.

4.5.5 pH value

When leather linings are tested in accordance with the method described in ISO 4045 : 1977, the pH value shall be not less than 3,5 and if the pH is below 4 the difference figure shall be less than 0,7.

4.6 Tongue

NOTE: The tongue need only be tested if the material from which it is made or its thickness differs from that of the upper material.

4.6.1 Tear strength

When determined in accordance with the appropriate method, the tear strength of the tongue shall be not less than the value given in table 11.

Table 11: Minimum tear strength of tongue

Type of material	Test method	Minimum force N
Leather	ISO 3377 : 1975	36
Coated fabric and textile	A.2* of ISO 4674 : 1977	18
* See table 6 for test conditions.		

4.6.2 pH value

When leather tongues are tested in accordance with the method described in ISO 4045 : 1977, the pH value shall be not less than 3,5 and if the pH is below 4 the difference figure shall be less than 0,7.

4.7 Insole

4.7.1 Thickness

When determined by the following method, the thickness of the insole shall be not less than 2,0 mm.

Cut through the sole in the region of the cleat and measure the thickness using a graduated eyepiece with 0,1 mm scale graduations.

4.7.2 pH value

When leather insoles are tested in accordance with the method described in ISO 4045 : 1977, the pH value shall be not less than 3,5 and if the pH is below 4 the difference figure shall be less than 0,7.

4.7 3 Water absorption and desorption

When tested in accordance with the method described in 5.15, the water absorption shall be not less than 35 % (m/m) and the water desorption shall be not less than 40 % (m/m) of the water absorbed.

4.7.4 Abrasion resistance

When non-leather insoles are tested in accordance with the method described in 5.16, there shall be no surface tearing before 400 cycles.

4.8 Outsole

4.8.1 Cleated outsoles

4.8.1.1 Cleated area

With the exception of the region under the flange of the toecap, at least the shaded area, as shown in figure 5, shall have cleats which are open to the side
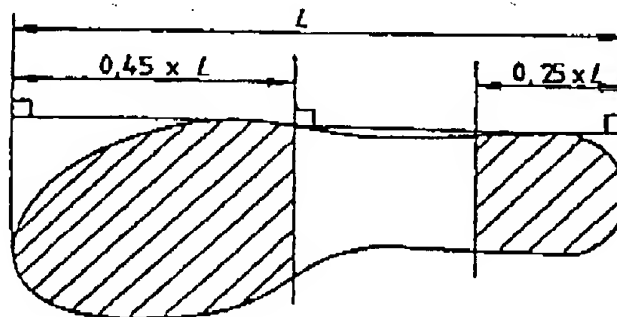
Figure 5: Cleated area

4.8.1.2 Thickness

For direct injected, vulcanized or cemented outsoles, the thickness d_1, as shown in figure 6(a) and 6(b), shall be not less than 4 mm.

For multilayered outsoles, the thickness d_1, as shown in figure 7, shall be not less than 4 mm.

For all-rubber and all-polymeric footwear, the thickness d_1, as shown in figure 8, shall be not less than 3 mm and the thickness d_3 shall be not less than 6 mm.

4.8.1.3 Cleat height

For direct injected, vulcanized or cemented outsoles, the cleat height d_2, as shown in figure 6(a) and 6(b), shall be not less than 2,5 mm.

For multi-layered outsoles, the cleat height, d_2, as shown in figure 7, shall be not less than 2,5 mm.

For all-rubber and all-polymeric footwear, the cleat height, d_2, as shown in figure 8, shall be not less than 4 mm.

> NOTE: Thickness or cleat height should be measured as indicated in figure 6(a), 6(b), 7 or 8, using a graduated eyepiece with 0,1 mm scale graduations after cutting through the sole in the region of the tread.

4.8.2 Thickness of non-cleated outsoles

The total thickness of a non-cleated outsole at any point shall be not less than 6 mm.

4.8.3 Tear strength

When non-leather outsoles are tested in accordance with the method described in ISO 34 : 1979 using the trouser test piece (method A), the tear strength shall be not less than 8 kN/m, except for mono-density polyurethane outsoles where the tear strength shall be not less than 5 kN/m.

The test piece shall be taken transverse to the longitudinal axis in the joint region, if possible.

4.8.4 Abrasion resistance

When non-leather outsoles other than those from all-rubber or all-polymeric footwear are tested in accordance with the method described in Method A of ISO 4649 : 1985 (with a vertical force of 10 N over an abrasion distance of 40 m), the relative volume loss shall be not greater than 250 mm^3 for materials with a density of 0,9 g/ml or less and not greater than 150 mm^3 for materials with a density higher than 0,9 g/ml. Test pieces shall be taken from the joint region.

For outsoles from all-rubber or all-polymeric footwear, tested as described, the relative volume loss shall be not greater than 250 mm^3.
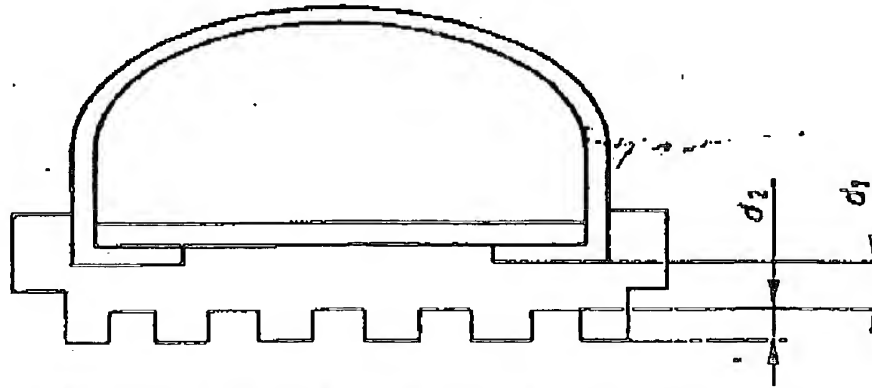
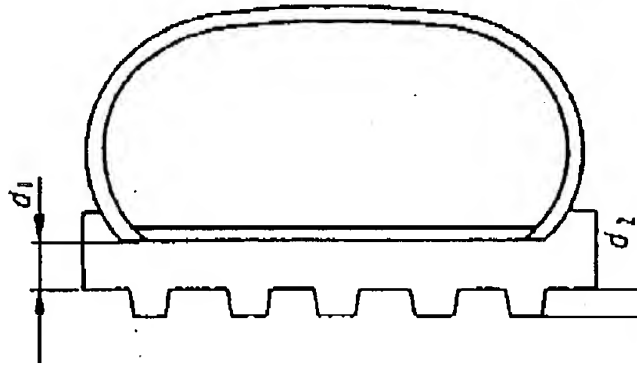d_2 d_1

Figure 6a: Conventional construction

d_1 d_2

Figure 6b: Strobel construction

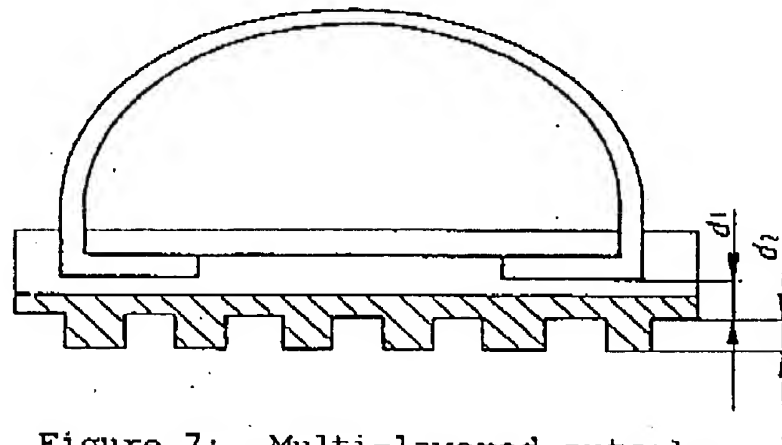Figure 6: Direct injected, vulcanized
and cemented outsoles

d_1 d_1

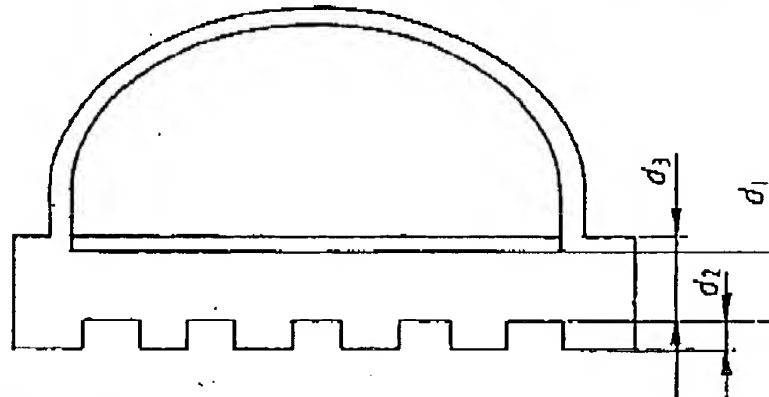Figure 7:   Multi-layered outsoles

d_3 d_1 d_2

Figure 8: All-rubber and all-polymeric
footwear

4.8.5 Flexing resistance

When non-leather outsoles, other than those from footwear with penetration resistant inserts or rigid soles, are tested in accordance with the method described in 5.17, the cut growth shall be not greater than 4 mm before 30 000 flex cycles.

4.8.6 Hydrolysis

When polyurethane outsoles are tested in accordance with the method described in annex C of ISO 5423 : 1992 after being prepared and conditioned as described in annex E of that standard, the cut growth shall be not greater than 6 mm before 150 000 flex cycles. The thickness of the test piece shall be 3 mm and conditioning at ambient temperature shall be carried out at 20 °C ± 2 °C.

4.8.7 Interlayer bond strength

When tested in accordance with the method described in 5.1, the bond strength between the outer or cleated layer and the adjacent layer shall be not less than 4,0 N/mm.

4.8.8 Resistance to hot contact

When tested in accordance with the method described in 5.18, rubber and polymeric outsoles shall not melt and shall develop no cracks when bent around the mandrel. When tested in the same way leather outsoles shall develop no cracks or charring which extend into the corium when bent around the mandrel.

4.8.9 Resistance to fuel oil

When tested in accordance with the method described in 5.19.1, the increase in volume shall be not greater than 12 %.

If the material shrinks or becomes brittle when tested in accordance with the method described in 5.19.1, a further test specimen shall be taken and tested in accordance with the method described in 5.19.2. The cut growth shall be not greater than 6 mm before 150 000 flex cycles.

5 Test methods

5.1 Determination of upper/outsole and sole interlayer bond strength

5.1.1 Principle

Measurement of the force required to separate the upper from the outsole or to separate adjacent layers of the outsole or to cause tear failure of the upper or the sole.

5.1.2 Apparatus

5.1.2.1 Tensile machine, with a means of continuously recording load, with a jaw separation rate of 100 mm/min ± 20 mm/min and a force range of 0 N to 600 N. The machine shall be fitted with either pincer or flat jaws (depending on the type of construction of the test sample), 25 mm to 30 mm wide, capable of firmly gripping the test pieces.

5.1.3 Preparation of test pieces

> NOTE: In all cases the objective should be to test the bond strength nearest to the edge of the assembly. The test need not be carried out w the bond has been made by grindery (using, for example, nails or screws) or stitching.

5.1.3.1 Sole/upper bond strength: construction type a (see figure 9)

Take a test piece from either the inner or the outer joint region.

Cut the test piece with sides at right angles to the edge of the sole using a press knife or bandsaw to cut through the upper, insole or outsole to produce a test piece about 25 mm wide. The length of the upper and sole should be about 15 mm measured from the feather line. (See figure 10.) Remove the insole.

5.1.3.2 Sole/upper bond strength: construction types b, c, d and e
(see figure 9)

Take a test piece from either the inner or the outer joint region.

Cut the upper and sole at X-X and Y-Y to produce a test piece with a width of about 10 mm and a length of not less than 50 mm. Remove the insole.

Separate the upper from the sole for a length of about 10 mm by inserting a hot knife into the adhesive layer. (See figure 11.)

> NOTE: It is considered that a construction is c or d when the distance from the line X-X to the upper face of the insole is at least 8 mm.

5.1.3.3 Sole interlayer bond strength: construction types f and g
(see figure 9)

Take a test piece from either the inner or the outer joint region.

Remove the upper by cutting along the feather line at X-X. Remove the insole if present. Cut a strip parallel to and including the sole edge at Y-Y to produce a test piece about 15 mm wide and at least 50 mm long.

Separate the sole layers for a length of about 10 mm by inserting a hot knife into the adhesive layer. (See figure 11.)

5.1.4 Measurement of bond strength

Before carrying out the test, measure the width of the test piece to the nearest mm at several points using a calibrated steel rule and calculate the average value to the nearest mm. Then measure the bond strength in one of the following ways.

    a) For sole/upper bond strength: construction type a.

    Clamp the test piece in the jaws of the tensile machine, using a pincer jaw to grip the short edge of the sole (see figure 12), and record the load/ deformation graph at a jaw separation speed of 100 mm/min ± 20 mm/min.

    b) For sole/upper bond strength: construction types b, c, d and e and sole interlayer bond strength: construction types f and g.

Clamp the separated ends of the test piece in the flat jaws and record the load/ deformation graph (see figure 13) at a jaw separation speed of 100 mm/min ± 20 mm/min.
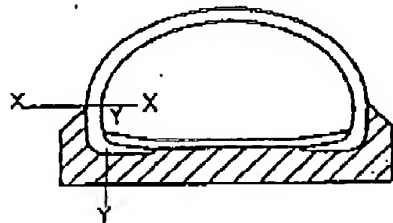
5.1.5 Calculation and expression of results

Estimate, from the load/deformation graph, the average peeling load in Newtons and divide by the average width to give the bond strength in N/mm.
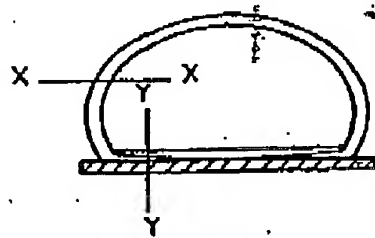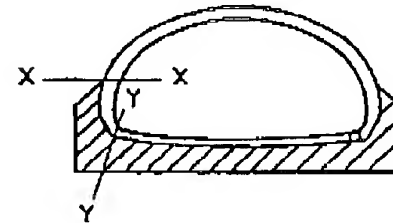
Type a: Conventional lasting
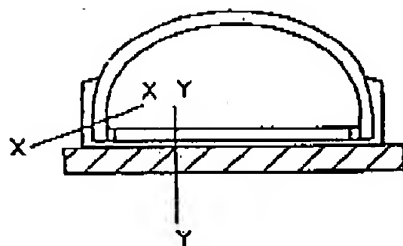Cemented or moulded outsole
having an extended edge
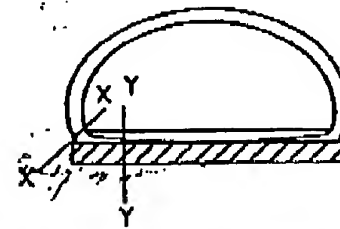
Type b: Conventional lasting
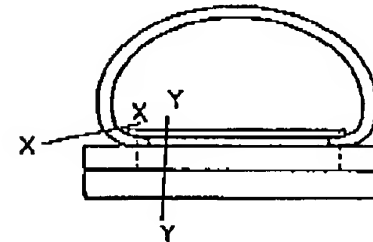Close trimmed outsole

Type c: Conventional lasting
Direct injected or vulcanized
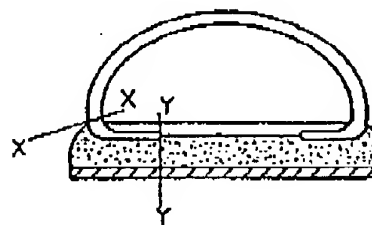outsole or cemented dished outsole

Type d: Strobel stitched
Cemented dished outsole
or direct injected
or vulcanized outsole

Type e: Conventional lasting or strobel
stitched with rubber mudguard
and cemented outsole

Type f: Machine sewn or welted
where the outsole is
bonded to the throughsole

Type g: Multi-layered sole
It may be moulded-on sole,
a moulded unit or a built unit

Figure 9: Types of construction showing position for preparation of
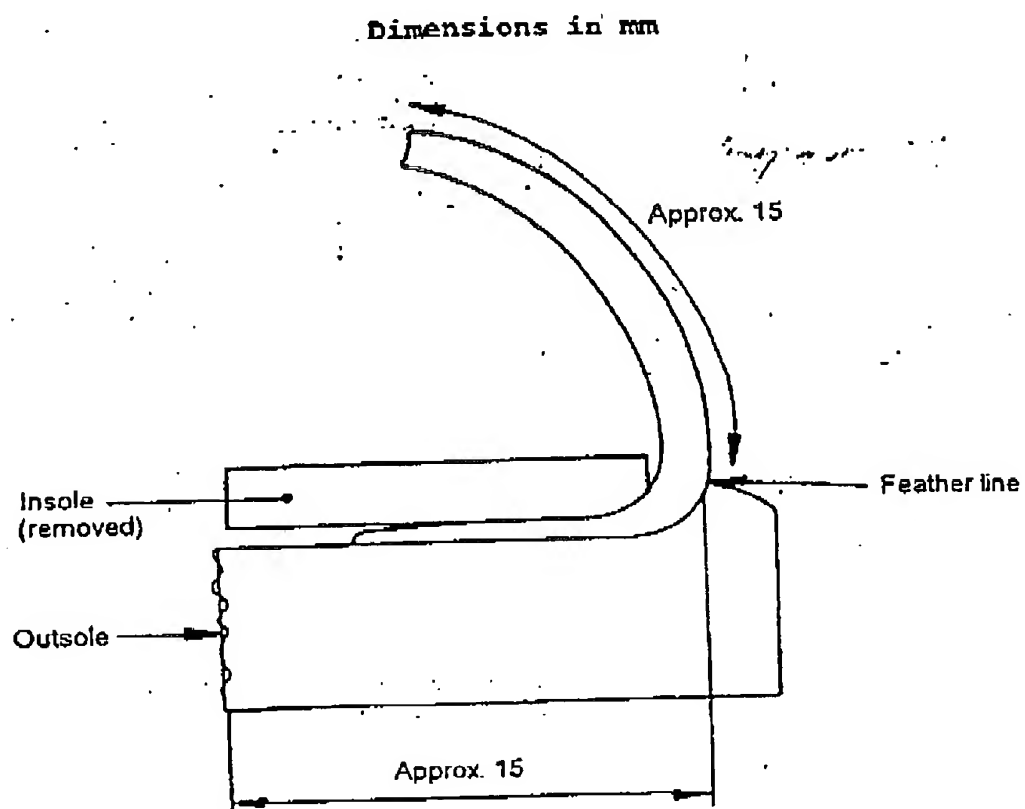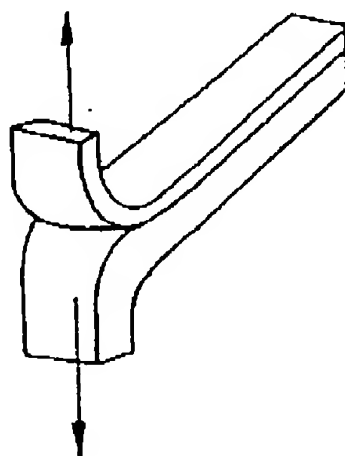the test piece for bond strength test

Dimensions in mm

Approx. 15

Insole
(removed)

Feather line

Outsole

Approx. 15

Figure 10: Cross section of test piece

Figure 11: Prepared test piece

Pincer jaw for
sole edge

Upper

Sole
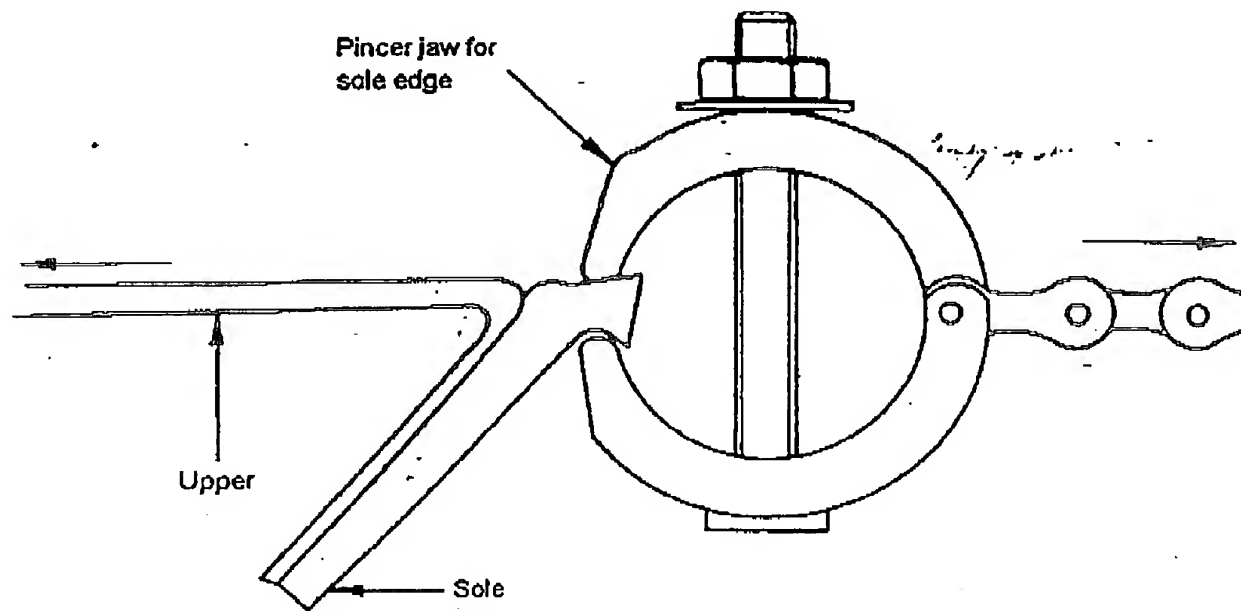
Figure 12: Pincer jaw showing position of test piece
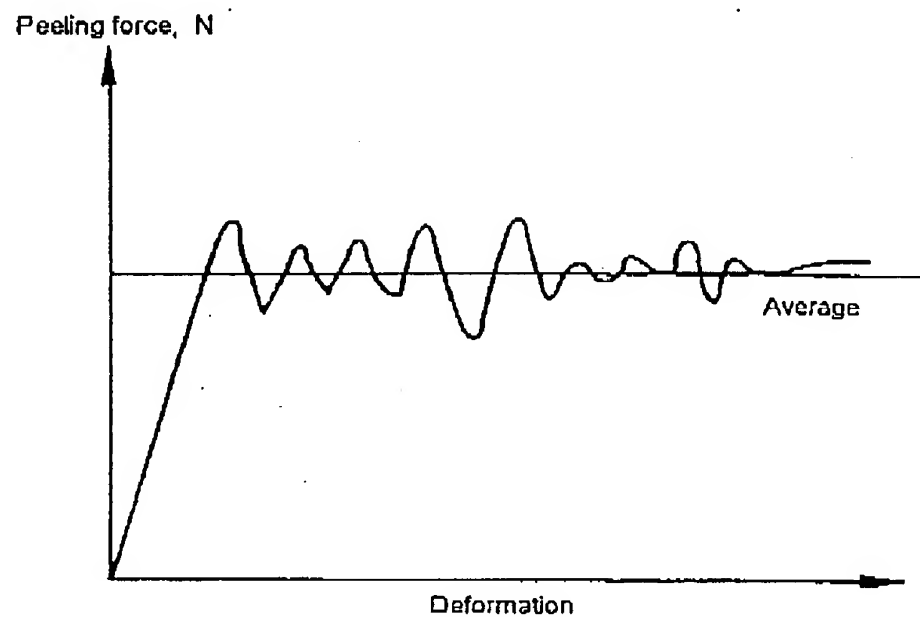
Peeling force, N

Average

Deformation

Figure 13: Example of load/deformation graph

5.2 Determination of internal toecap length

5.2.1 Preparation of test piece

Carefully extract the toecaps from an untested pair of footwear.

Preconditioning of the test piece is unnecessary.

5.2.2 Determination of the test axis

Position the left toecap with its rear edge in line with a base line and draw its outline. Repeat the exercise with the right toecap of the pair. Position the outlines in such a manner that the outlines at the toe end of the toecaps coincide and the base lines coincide. (See figure 14.)

Mark the four points A, B, C and D where the outlines of the right and left toecaps intersect on the base line. Erect the perpendicular from the base line at the mid point of AB or CD. This constitutes the test axis for the toecap.

5.2.3. Test procedure

Place the toecap, open side down, on a flat surface. Using an appropriate gauge, measure the internal length, l, along the test axis from the toe to the back edge at a distance of 3 mm ± 0,5 mm above and parallel to the surface upon which the toecap rests. (See figure 15.)
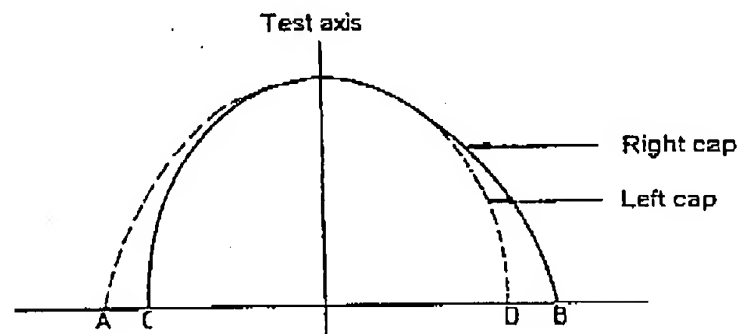

Figure 14: Determination of test axis

Dimensions in mm

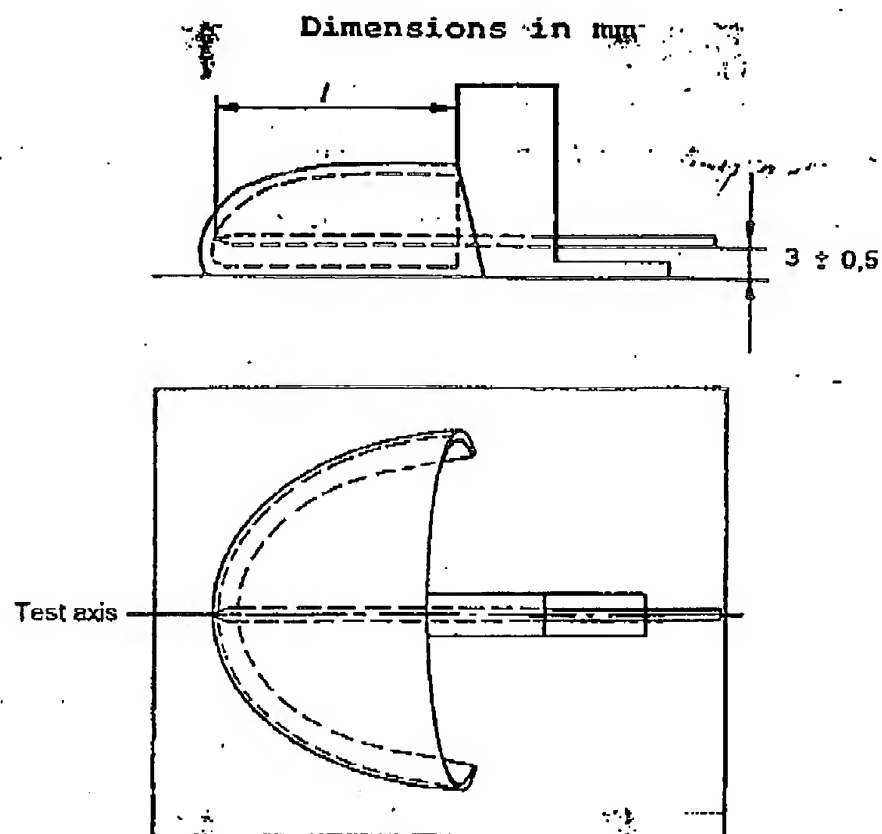$3 \div 0.5$

Test axis

Figure 15: Measurement of internal
toecap length

5.3 Determination of impact resistance

5.3.1 Apparatus

5.3.1.1 **Impact apparatus**, incorporating a steel striker of mass 20 kg ± 0,2 kg adapted to fall freely on vertical guides from a predetermined height to give the required impact energy calculated as potential energy.

The striker (see figure 16) shall consist of a wedge at least 60 mm long, the faces of which subtend an angle of 90° ± 1°. The apex where the faces meet shall be rounded to a 3 mm ± 0,1 mm radius. During the test the apex shall be parallel within ± 17' to the surface of the clamping device.

The base of the apparatus shall have a mass of at least 600 kg and a metal block of dimensions at least 400 mm x 400 mm x 40 mm deep shall be bolted to it.

The apparatus shall be free standing on a flat and level floor which is sufficiently massive and rigid to support the test equipment.

> NOTE: Provision should be made for a mechanism to catch the striker after the first impact so that the test specimen is struck only once.

5.3.1.2 **Clamping device**, consisting of a smooth steel plate at least 19 mm thick and 150 mm x 150 mm in area of minimum hardness 60 HRC with a screw clamp for clamping the insole of the toe-end of the footwear under test to the plate in a way which will not restrict any lateral expansion of the toecap during the impact test. (See figure 17). The stabilising fork, which is to be introduced into the front part of the footwear, shall be adjusted by means of the adjusting screw to rest on the insole, parallel to the base-plate. The clamping screw (M8 thread) shall be tightened by applying a torque of 3 Nm ± 1 Nm.

5.3.1.3 **Cylinders**, of modelling clay of diameter 25 mm ± 2 mm and of height 20 mm ± 2 mm for footwear up to and including size 40 (Paris points) and 25 mm ± 2 mm for footwear above size 40.

The flat surfaces of the cylinders shall be covered with aluminium foil to prevent them sticking to either the test specimen or the test equipment.

5.3.1.4 **Dial gauge**, with a hemispherical foot of 3,0 mm ± 0,2 mm radius and a hemispherical anvil of 15 mm ± 2 mm radius exerting a force of not greater than 250 mN.

5.3.2 Procedure

5.3.2.1 Determination of the test axis (see figure 18)

Locate the testing axis by placing the footwear on a horizontal surface and against a vertical plane so that it touches the edge of the sole at points A and B on the inner side of the footwear. Construct two further vertical planes at right angles to the first vertical plane so that they meet the sole at points X and Y, the toe point and heel point respectively. Draw a line through X and Y. This constitutes the test axis for the forepart of the footwear.

5.3.2.2. Preparation of test piece

Prepare the forepart of the footwear by cutting off the toe end 30 mm behind the rear edge of the toecap. Do not remove the upper and lining. If the footwear has been supplied with a removable insock, carry out the test with it in place.

Preconditioning of the test piece is unnecessary.

5.3.2.3 Test procedure

Position a cylinder (5.3.1.3) on one of its ends inside the test piece with the centre of the cylinder on the test axis and the back edge of the cylinder level with the rear edge of the cap. (See figure 19)

Position the test piece in the impact apparatus (5.3.1.1) so that when the striker hits it, the striker shall project over the back and front of the toecap. Adjust the clamping device (5.3.1.2).

Allow the striker to drop on to the test axis from the appropriate height to give an impact energy of 200 J ± 4 J for safety footwear or 100 J ± 2 J for protective footwear.

Measure, to the nearest 0,5 mm, the lowest height to which the cylinder has been compressed within 10 mm of the impression of the back edge of the toecap using the dial gauge (5.3.1.4). This value is the clearance at the moment of impact.
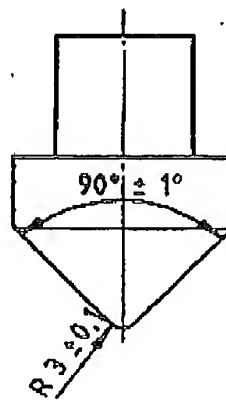
Dimensions in mm

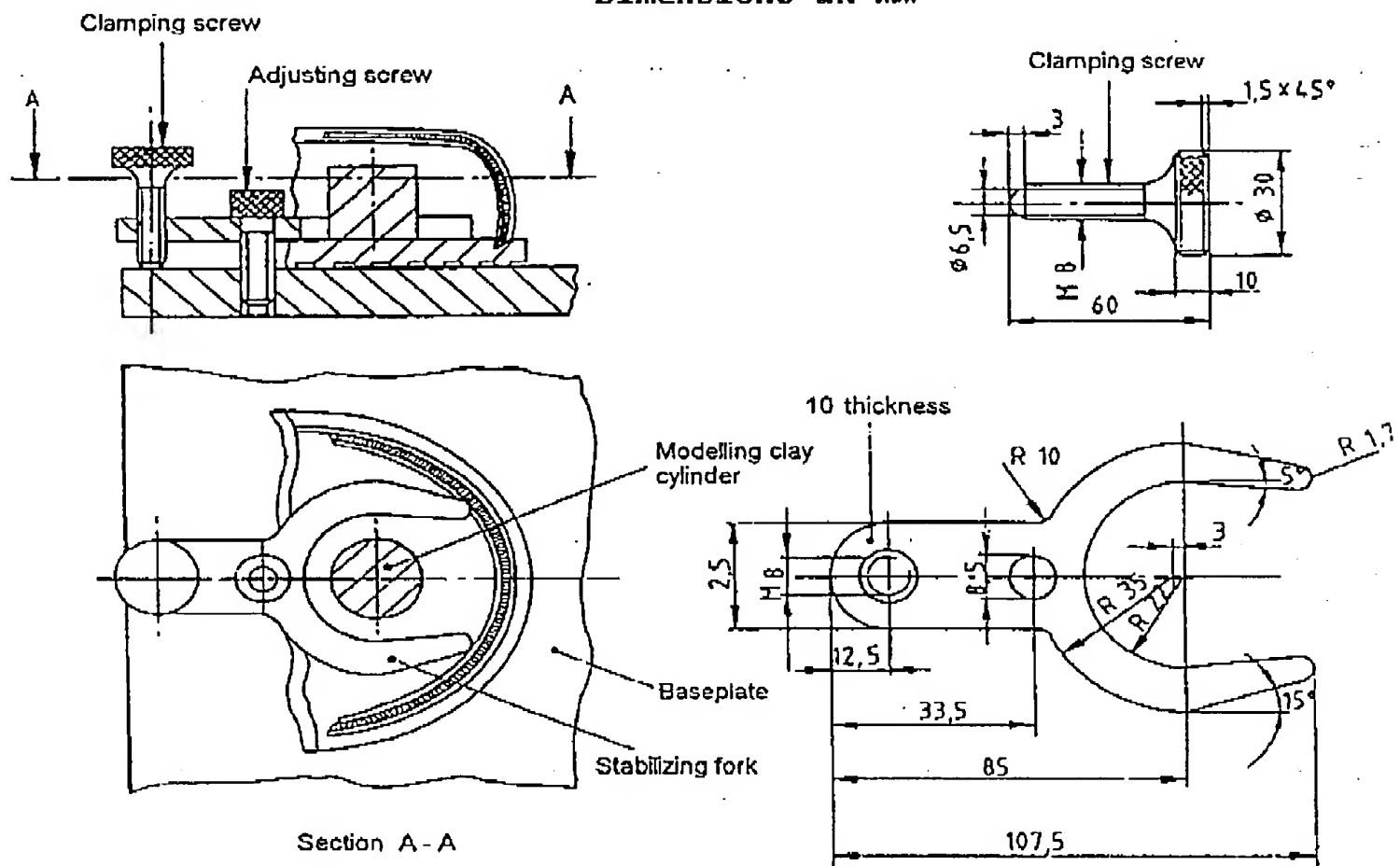Figure 16:   Impact striker

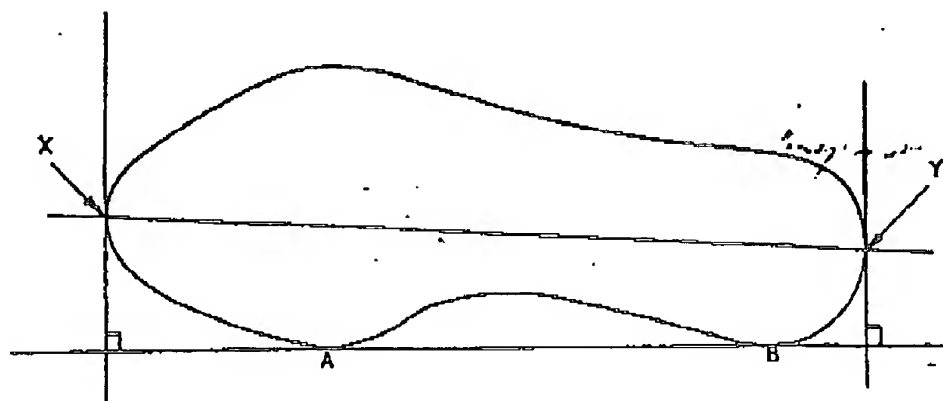Dimensions in mm

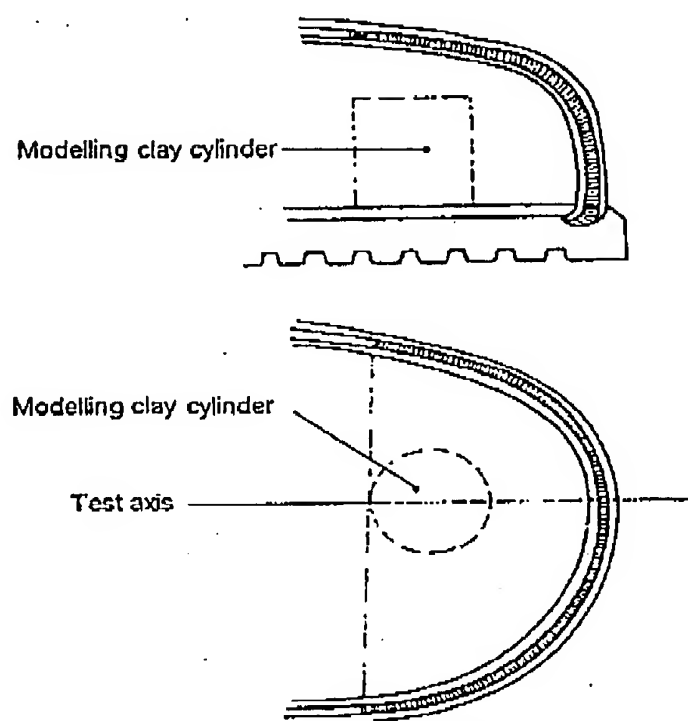Figure 17: Footwear clamp

Figure 18:   Test axis for footwear

Figure 19:   Position of cylinder for impact
or compression test of footwear

5.4   Determination of compression resistance

5.4.1   Apparatus

5.4.1.1   Compression testing machine capable of subjecting the test piece to a force of at least 20 kN (to a tolerance of ± 1%) between plattens which move at a speed of 5 mm/min ± 2 mm/min.   The plattens shall remain parallel during the application of the load and shall have a minimum hardness of 60 HRC.   The measurement of the force shall not be affected by eccentrically applied forces.

5.4.1.2   Cylinders, as described in 5.3.1.3.

5.4.1.3   Dial gauge, as described in 5.3.1.4.

5.4.2   Procedure

5.4.2.1   Determination of the test axis

Determine the test axis as described in 5.3.2.1.

5.4.2.2   Preparation of test piece

Prepare the test piece as described in 5.3.2.2.

Preconditioning of the test piece is unnecessary.

5.4.2.3   Test procedure

Position a cylinder (5.4.1.2) on one of its ends inside the test piece with the centre of the cylinder on the test axis and the back edge of the cylinder level with the rear edge of the cap.   (See figure 19.)

Position the test piece between the plattens of the compression machine (5.4.1.1) and compress the test specimen to a load of either 15 kN ± 0,1 kN for safety footwear or 10 kN ± 0,1 kN for protective footwear.   (See figure 20.)

Reduce the load, remove the cylinder and measure, to the nearest 0,5 mm, the lowest height to which the cylinder has been compressed within 10 mm of the impression of the back edge of the toecap using the dial gauge (5.4.1.3).   This value is the compression clearance.
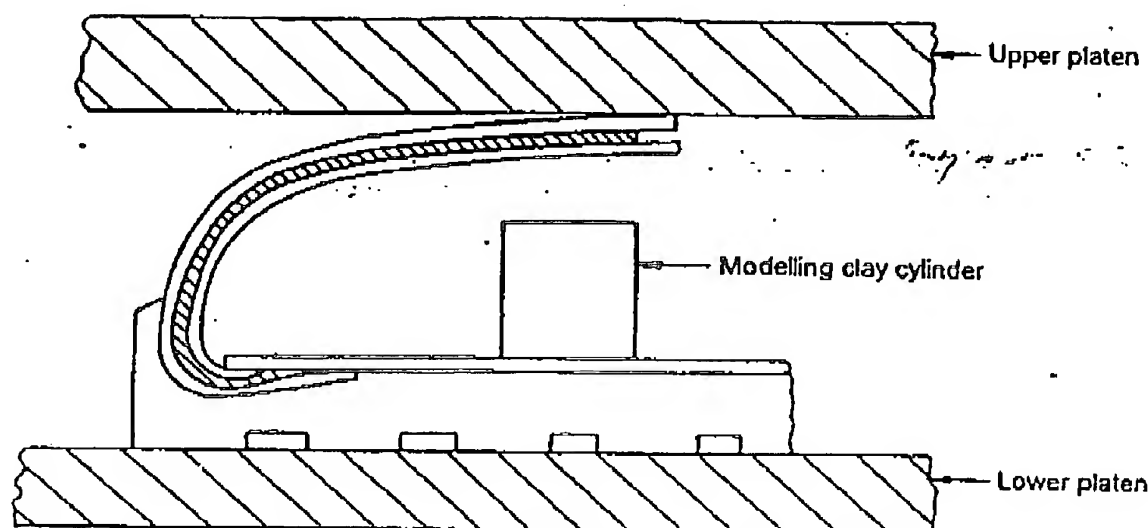
Figure 20: Apparatus for compression test

5.5 Determination of corrosion resistance of metal toecaps or metal penetration resistant inserts in all-rubber footwear

5.5.1 Preparation of test piece

Use the complete item of footwear as the test piece.

Preconditioning of the test piece is unnecessary.

5.5.2 Test solution

Use a 1 % (m/m) aqueous piece of sodium chloride.

5.5.3 Procedure

Pour sufficient test solution into the test piece to fill it up to a depth of 150 mm. Cover the top of the footwear with, for example, a polyethylene cover, to minimize evaporation.

Allow to stand for 7 days and then discard the test solution.

Remove the toecap or insert from the footwear and examine for any evidence of corrosion. When present, measure the size of each area of corrosion in mm^2 and record also the number of such areas.

5.6 Determination of penetration resistance

5.6.1 Apparatus

5.6.1.1 Test equipment, capable of measuring compressive force up to at least 2000 N, fitted with a pressure plate, in which a test nail, (5.6.1.2) is fixed, and a parallel base plate with a circular opening of diameter 25 mm. The axes of this opening and the test nail are coincident (see figure 21).

5.6.1.2 Test nail, of diameter 4,50 mm ± 0,05 mm with a truncated end of the form and dimensions shown in figure 22. The point of the nail shall have a minimum hardness of 60 HRC.

> NOTE: The form of the test nail should be examined at intervals and if departures from the dimensions shown in figure 22 are observed the test nail should be replaced.

5.6.2 Procedure

5.6.2.1 Preparation of test piece

Remove the upper from the sole unit and use the sole unit as the test piece.

Preconditioning of the test piece is unnecessary.

5.6.2.2 Test procedure

Place the sole unit on the base plate in such a way that the steel nail can penetrate it through the outsole. Press the nail against the sole unit at a speed of 10 mm/min ± 3 mm/min until the point has penetrated and measure the maximum force required.

Carry out the test at four different points on the sole unit (at least one in the heel region) with a minimum distance of 30 mm between any two penetration points and at a minimum distance of 10 mm from the edge of the insole. For cleated soles, carry out the test between cleats. Two of the four measurements shall be made at a distance of 10 mm to 15 mm from the line represented by the feather edge of the last.

If moisture can affect the results obtained, carry out the tests after the sole unit has been immersed in deionized water at 20 °C ± 2 °C for 16 h ± 1 h.

Report the minimum value of the individual measurements as the test result.
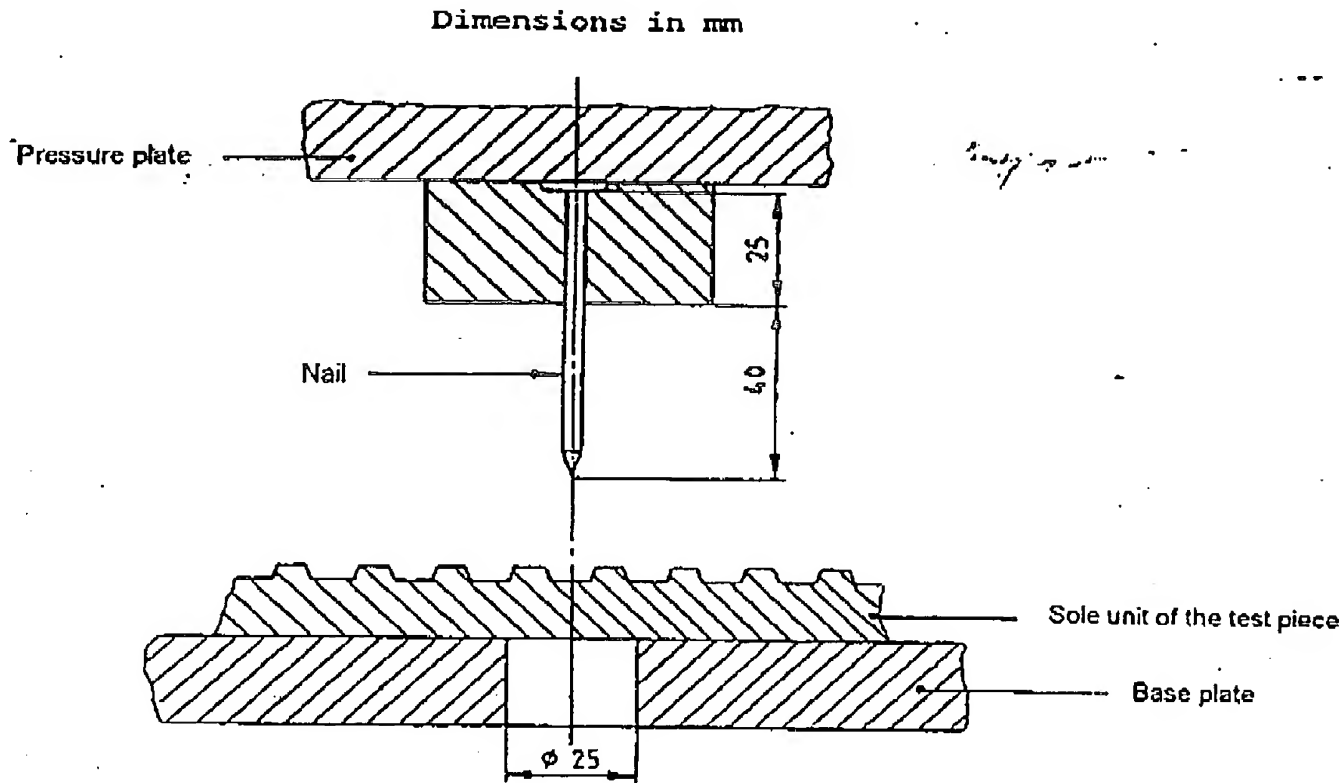
Dimensions in mm

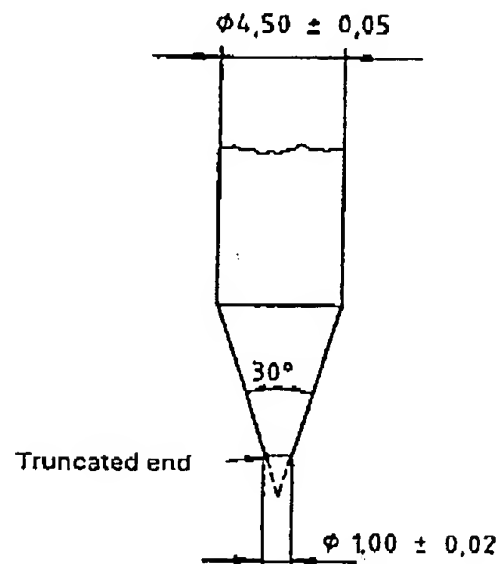Figure 21: Apparatus for penetration resistance test

Figure 22: Nail for penetration resistance test

5.7 Determination of electrical resistance

5.7.1 Apparatus

5.7.1.1 Testing instrument capable of supplying a voltage of 100 V ± 2 V, measuring accuracy within 5 % and including a device to ensure that it does not dissipate more than 3 W in the product.

5.7.1.2 Internal electrode comprising steel balls of 5 mm diameter and of total mass 4 kg.

> NOTE: Ball bearings complying with the requirements of ISO 3290 : 1975 are suitable.

5.7.1.3 External electrode comprising a copper contact plate cleaned before use with ethanol.

> NOTE: Steps should be taken to prevent oxidation of the steel balls and the copper plate since oxidation could affect their conductivity.

5.7.1.4 Conductive lacquer.

5.7.1.5 Device for measuring the electrical resistance of the lacquer, consisting of three conductive metal probes, each of 3 mm ± 0,2 mm radius, attached to a base plate. Two of the probes are 45 mm ± 2 mm apart and connected by a metal strap. The third probe is set at a distance of 180 mm ± 5 mm from the centre of a line joining the other two and is electrically insulated from them.

5.7.2 Preparation and conditioning of test piece

5.7.2.1 Preparation. Clean the surface of the sole of the footwear with ethanol to eliminate all traces of mould silicone, wash with distilled water and allow to dry at 20 °C ± 2 °C. The surface shall not be buffed or abraded or cleaned with organic materials which attack or swell the sole.

For test pieces which are to be tested following conditioning under wet conditions, apply a conductive lacquer (5.7.1.4) to the sole over an area 200 mm by 50 mm, including the heel and fore part. Allow to dry and then check that the resistance of the lacquer is less than $10^3 \, \Omega$ by testing in accordance with 5.7.2.2.

5.7.2.2 <u>Measurement of the electrical resistance of the applied lacquer</u>. Fill the footwear with clean steel balls and place on the metal probes of the device (5.7.1.5) such that the front area of the outsole is supported by the two probes spaced 45 mm apart and the heel area is supported by the third probe. Using the testing instrument (5.7.1.1), measure the resistance between the front probes and the third probe.

5.7.2.3. <u>Conditioning</u>. Condition the prepared test piece in one of the following atmospheres, according to the type of footwear being tested:

    a) Dry conditions. $20\ °C \pm 2\ °C$ and $30\% \pm 3\ \%$ r.h. for 7 days;

    b) Wet conditions. $20\ °C \pm 2\ °C$ and $85\% \pm 3\ \%$ r.h. for 7 days.

The tests shall be performed within 5 min of the removal of the test specimen from the conditioning atmosphere if the test is not to be carried out in that atmosphere.

5.7.3 <u>Procedure</u>

Fill the test piece with clean steel balls to a total mass of 4 kg using a piece of insulating material to extend the height of the upper if necessary. Place the filled specimen on the copper plate, apply a test voltage of $100\ V \pm 2\ V$ d.c. between the copper plate and the steel balls for 1 min and calculate the resistance.

    NOTE: If the voltage falls below the value specified, because of the limit of 3 W maximum dissipated energy, take measurements at that lower voltage and record it.

5.8 Determination of insulation against heat

5.8.1 <u>Apparatus</u>

5.8.1.1 <u>Sandbath</u>, fitted with a hotplate which can be regulated to $150\ °C \pm 5\ °C$ (see figure 23).

5.8.1.2 <u>Heat transfer medium</u>, comprising steel balls of 5 mm diameter and of total mass 4 kg.

    NOTE: Ball bearings complying with the requirements of ISO 3290 : 1975 are suitable.

5.8.1.3 <u>Copper/copper-nickel thermocouple</u>, soldered to a copper disc $2\ mm \pm 0,1\ mm$ thick and $15\ mm \pm 1\ mm$ diameter.

5.8.1.4 <u>Temperature measuring device</u>, with a compensator, suitable for use with 5.8.1.3.

5.8.2 Procedure

5.8.2.1 Preparation of test piece

Use the complete item of footwear as the test piece. Condition it for 7 days at 20 °C ± 2 °C and 65 % ± 2 % r.h. Fix the thermocouple to the insole in the centre of the joint area and place the steel balls inside the footwear. If the upper is not high enough to accommodate the balls, increase its height with a collar.

5.8.2.2 Test procedure

Condition the prepared test piece until the temperature of the insole is constant at 20 °C ± 2 °C and carry out the test under ambient conditions of 20 °C ± 2 °C.

Adjust the temperature of the sandbath to 150 °C ± 5 °C and place the test piece on it with sand up to the upper edge of the outsole. Use the temperature measuring device connected to the thermocouple to measure the temperature on the insole as a function of time, recording the temperature increase graphically.

Calculate to the nearest 0,5 °C, the increase in temperature after 30 min from the time the test piece was placed on the sand bath.
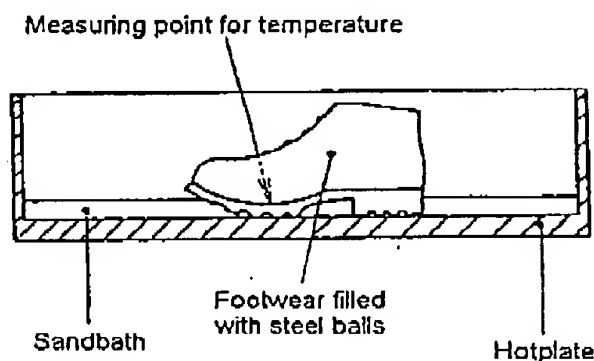

Figure 23: Heat insulation
test apparatus

5.9 Determination of insulation against cold

5.9.1 Apparatus

5.9.1.1 **Insulated cold box**, the internal air temperature of which can be regulated to – 20 °C ± 2 °C. (See figure 24.)

5.9.1.2 **Heat transfer medium**, as described in 5.8.1.2.

5.9.1.3 **Thermocouple**, as described in 5.8.1.3.

5.9.1.4 **Temperature measuring device**, as described in 5.8.1.4.

5.9.1.5 **Copper/zinc alloy plate**, of 5 mm thickness, positioned as illustrated in figure 24.

5.9.2 Procedure

5.9.2.1 Preparation of test piece

Prepare the test piece as described in 5.8.2.1

5.9.2.2 Test procedure

Condition the prepared test piece until the temperature of the outsole is constant at 20 °C ± 2 °C and carry out the test under ambient conditions of 20 °C ± 2 °C.

Adjust the temperature of the cold box to – 20 °C ± 2 °C.   Place the test piece on the laboratory jack inside the cold box, adjusting the height so that the top line of the footwear is level with the opening and seal the opening with a heat insulating cover.

Use the temperature measuring device connected to the thermocouple to measure the temperature on the insole as a function of time, recording the temperature decrease graphically.

Calculate, to the nearest 0,5 °C, the decrease in temperature after 30 min from the time the test piece was placed in the cold box.

Dimensions in mm

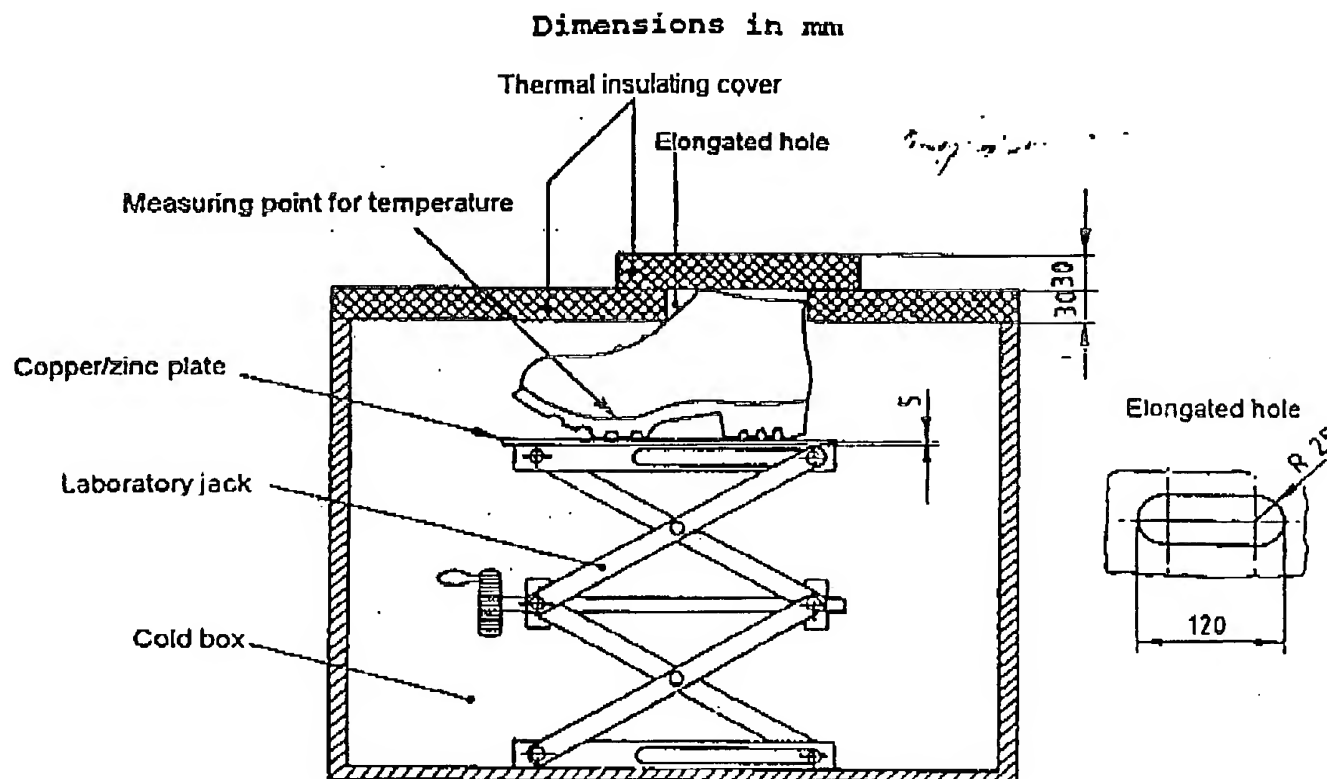

Figure 24: Cold insulation test
apparatus

5.10 Determination of energy absorption of seat region

5.10.1 Apparatus

5.10.1.1 Test equipment, capable of measuring compressive forces up to 6000 N, with a means of recording load/deformation characteristics.

5.10.1.2 Test punch, being the back part of a standardized last made in polyethylene [1]. The last is sectioned on a plane vertical to the feather edge and at 90° to the axis of the back part. (See figure 25.) The length of the punch in relation to footwear size is given in table 12.

---

[1] Information on the availability of suitable punches may be obtained from the Secretariat of CEN/TC161.

Table 12: Length of test punch

Footwear size		Length, L
Paris points	English	mm
36 and below	3 and below	65,0
37 and 38	4 and 5	67,5
39 and 40	6	70,0
41 and 42	7 and 8	72,5
43 and 44	9 and 10	75,0
45 and above	11 and above	77,5

5.10.2 Procedure

Place the footwear with the heel on a steel base and press the test punch against the sole unit from the inside at the centre of the heel area at a test rate of 10 mm/min ± 3 mm/min until a force of 5000 N is obtained.

Plot a load/compression curve for each test and determine the energy absorption E in joules, rounded to the nearest 1 J, from the equation:

$$E = \int_{50\ N}^{5000\ N} F \cdot ds$$

where

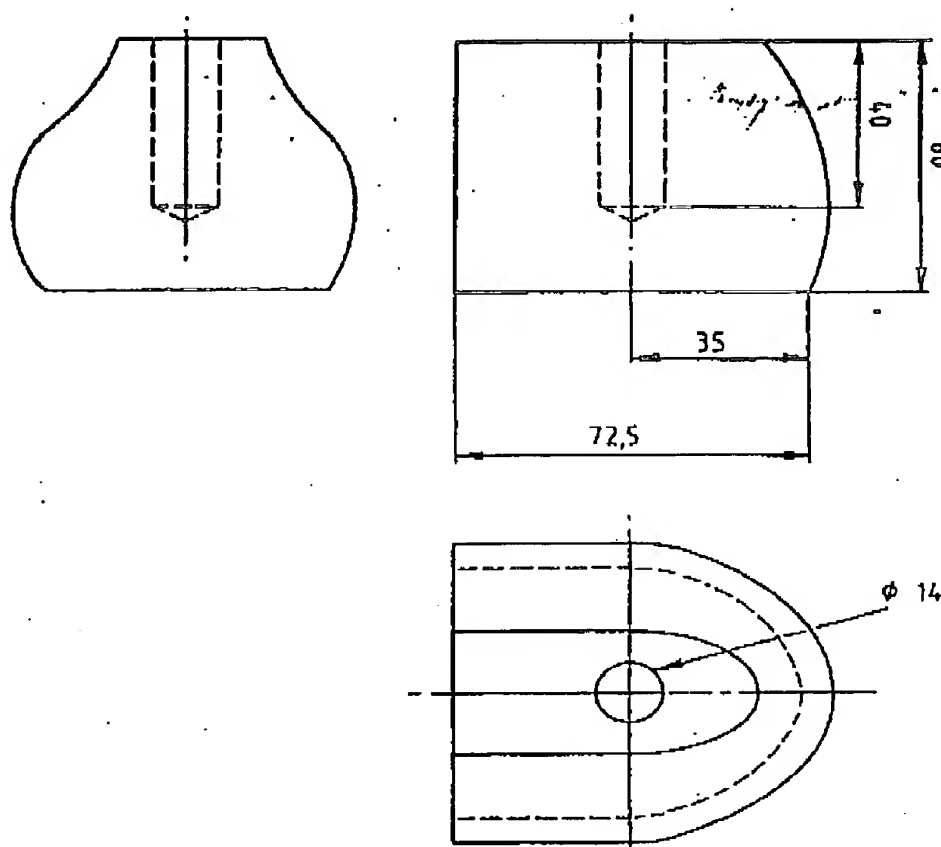F is the applied force, in N;
s is the distance, in mm.

Dimensions in mm

Figure 25: Test punch for energy
absorption test

5.11 Determination of leakproofness

5.11.1 Apparatus

5.11.1.1 Waterbath.

5.11.1.2 Supply of compressed air.

5.11.2 Preparation of test piece

Take the entire item of footwear as the test piece.

5.11.3 Procedure

Carry out the test at a temperature of 20 °C ± 2 °C.

Seal the top edge of the test piece, e.g. with a rubber collar through which
compressed air may be fed via appropriate connections. Immerse the test
specimen in a waterbath up to the edge and apply a constant internal pressure of
50 kPa ± 10 kPa for 30 s. Observe the test piece throughout the test and
determine whether there is a continued formation of air bubbles, indicating
leakage of air.

5.12 Determination of water penetration and water absorption

5.12.1 Principle

The material is partially immersed in water and flexed on a machine in a manner simulating conditions of wear. Measurements are made of:

   a) the percentage gain in mass of the test piece due to water absorption 60 min from the start of the test;

   b) the time taken from the start of the test for water just to penetrate through the test piece;

   c) the mass of water which has passed through the test piece after a further 30 min.

5.12.2 Apparatus

5.12.2.1 Two cylinders, 30 mm diameter, made of inert rigid material, mounted with their axes horizontal and co-axial. One cylinder is fixed and the other is movable along the direction of its axis.

5.12.2.2 Electric motor, which drives the movable cylinder backwards and forwards along its axis with crank motion at 50 cycles/min and with amplitude which can be varied from 1,0 mm to 3,0 mm about its mean position. When the movable cylinder is at its greatest distance from the fixed one, the adjacent flat faces of the two cylinders are 40 mm apart.

5.12.2.3 Ring-shaped clamps, to clamp the longer edges of the test piece round the adjacent ends of the cylinders so that it forms a trough whose ends are closed by the cylinders.

5.12.2.4 Tank, containing distilled water, in which the trough-shaped test piece can be partly immersed.

5.12.2.5 Mass of fine spiral brass lathe turnings, forming an easily compressible conducting cushion which occupies two-thirds of the space in the trough formed by the test piece when positioned in the apparatus.

5.12.2.6 Metallic plate electrode, carried by a spring, to make contact with the top of the brass turnings and which, when resting on the turnings or the roll of absorbent cloth applies a load of 1 N to 2 N.

5.12.2.7 Suitable electric circuit, which gives a signal when the electrical resistance between the plate electrode and the water in the tank decreases below a fixed value, thus indicating that penetration of water through the test piece has occurred.

5.12.2.8 Absorbent cloth, used to absorb water transmitted to the interior of the trough formed by the test piece. A suitable cloth consists of a rectangle of towelling-type textile of approximately 120 mm x 40 mm with a mass of approximately 300 g/m².

> NOTE: The absorbency of the material may not be optimal when new. It is therefore advisable to wash the cloths before their first use.

5.12.2.9 Stopwatch.

5.12.2.10 Balance, capable of weighing to 0,001 g.

5.12.3 Preparation of test piece

Cut from the upper a rectangle of 75 mm x 60 mm. Buff the wear surface lightly by rubbing with a grade 180 emery paper and condition for 48 h at 20 °C ± 2 °C and 65 % ± 2 % r.h.

5.12.4 Procedure

Adjust the apparatus to give an amplitude of 3 mm (7,5 % compression of the test piece).

Weigh the test piece to the nearest 0,001 g and record its mass, M_1.

Fix the test piece in the apparatus, with the wear surface outside, as follows.

With the two cylinders at their maximum distance apart wrap the test piece round their adjacent ends so that it forms a trough whose upper edges, formed by the shorter sides of the test piece, are horizontal and at the same level. Keep the test piece between the cylinders under slight tension to remove folds and with approximately the same length (about 10 mm) overlapping on each cylinder, clamp it using the ring clamps. The inner edges of the two ring clamps should lie as nearly as possible in the planes of the adjacent ends of the cylinders, so that the length of the trough is the same as the free length of the test piece between the clamps.

Place the brass turnings (5.12.2.5) into the trough, lower the plate electrode (5.12.2.6) to make contact with them and connect the electric circuit (5.12.2.7).

Raise the level of water in the tank until the water lies 10 mm below the top of the cylinders.

Start the motor and measure the time interval until water first penetrates through the test piece, as indicated by a signal from the electric circuit.

After 60 min from the start of the test, stop the motor and remove the plate electrode and brass turnings. Remove the test piece, blotting lightly to remove adhering moisture, and reweigh, recording its mass M_2.

Replace the test piece. Weigh the absorbent cloth (5.12.2.8), recording its mass P_1, roll it up to form a cylinder of 40 mm length and immediately place it in the trough formed by the test piece. Replace the plate electrode (5.12.2.6) so that it rests on the cloth and restart the motor.

After a further 30 min, stop the motor, remove the cloth, if necessary mopping up any surplus water within the trough, and reweigh, recording its mass P_2.

5.12.5 Calculation and expression of results

5.12.5.1 Calculate the water penetration, W_p, in g from the equation:

$$W_p = P_2 - P_1$$

where

P_1 is the initial mass of the absorbent cloth, in g;
P_2 is the final mass of the absorbent cloth, in g.

5.12.5.2 Calculate the water absorption, W_a, as a percentage by mass, from the equation:

$$W_a = \frac{M_2 - M_1}{M_1} \times 100$$

where

M_1 is the initial mass of the test piece, in g;
M_2 is the final mass of the test piece, in g.

5.13 Determination of water vapour permeability and water vapour coefficient

5.13.1 Determination of water vapour permeability

5.13.1.1 Principle

The test piece is fixed over the opening of a jar which contains a quantity of solid desiccant. This unit is placed in a strong current of air in a conditioned atmosphere.

The air inside the container is constantly agitated by the desiccant which is kept in movement by the rotation of the jar.

The jar is weighed in order to determine the mass of moisture that has passed through the test piece and been absorbed by the desiccant.

5.13.1.2 Apparatus

5.13.1.2.1 Jars or bottles fitted with a screw top with a circular opening whose diameter is equal to the diameter of the neck of the jar (approximately 30 mm) (see figure 26).

5.13.1.2.2 Holder in the form of a disc which is rotated at 75 r/min ± 5 r/min by an electric motor. The jars are placed on this disc with their axes parallel to the axle of the disc and at a distance of 67 mm from it (see figure 27).

5.13.1.2.3 <u>Fan</u>, mounted in front of the mouths of the jars and consisting of three flat blades in planes that are inclined at 120° to one another. The planes of the blades pass through the prolongation of the axle of the disc. The blades are of dimensions approximately 90 mm by 75 mm, and the 90 mm long side of each blade nearest the mouths of the jars passes them at a distance of not more than 15 mm. The fan is driven by the motor at 1400 r/min ± 100 r/min. The apparatus is used in a conditioning atmosphere (20 °C ± 2 °C, 65 % ± 2 % r.h.) (see figure 28).

5.13.1.2.4 <u>Silica gel desiccant</u>, freshly regenerated by at least 16 h in a ventilated oven at 125 °C ± 5 °C then cooled to ambient temperature in a hermetically sealed vessel. The granular size of the crystals shall be such that they shall not pass through a 2 mm sieve.

NOTE: The silica gel should be sieved before regeneration in order to eliminate small particles and dust. At regeneration, the specified temperature should not be exceeded due to the risk of reducing the absorptive capacity of the gel. The ventilation of the oven by use of a fan is not necessary but the oven should not be sealed; it should allow continuous exchange of the air inside the oven with that outside. The gel should not be used whilst it is warmer than the test piece and since it cools slowly in a closed vessel, a long cooling time is needed.

5.13.1.2.5 <u>Balance</u>, capable of weighing to 0,001 g.

5.13.1.2.6 <u>Stopwatch</u>.

5.13.1.2.7 <u>Instrument</u>, capable of measuring to the nearest 0,1 mm the internal diameter of the neck of the jars.

5.13.1.3 <u>Preparation of the test piece</u>

Cut a test sample of dimensions 50 mm x 50 mm.

Buff the grain surface lightly, as follows.

Place the sample grain upwards on a table. Press a piece of grade 180 emery paper against the sample and draw it across 10 times in various directions under a load of about 200 g applied by hand pressure.

Cut a circular test piece of diameter 34 mm, corresponding to the external diameter of the neck of the jars.

5.13.1.4 <u>Test procedure</u>

Half fill a jar with freshly regenerated silica gel. Fix the test piece over the opening of the jar by means of the screw top with the side facing the foot pointing outwards. Place the jar in the holder of the apparatus and switch on the machine.

Measure the internal diameter of the neck of a second jar (to the nearest 0,1 mm) in two directions perpendicular to each other and calculate the average diameter in mm.

If it is necessary to seal the junction between the test piece and the neck of the jar, warm the second bottle and apply a thin layer of wax to the flat end surface of the neck.

After more than 16 h but less than 24 h stop the machine, and remove the first jar. Half fill the second jar with freshly regenerated silica gel and immediately remove the test piece from the first jar and place onto the second (with the same side facing outwards).

> NOTE: If the opening of the jar has been coated with wax, warm the jar to around 50 °C before introducing the silica gel and fixing the test piece.

As quickly as possible, weigh the second jar with the test piece and silica gel, mass M_1, noting the time. Place the jar in the apparatus and switch on.

After not less than 7 h and not more than 16 h stop the machine and reweigh the jar, mass M_2, noting once again the time.

5.13.1.5 Calculation and expression of results

Calculate the water vapour permeability from the equation:

$$WVP = \frac{7639\,M}{d^2 t}$$

where

WVP is the water vapour permeability, in $mg/(cm^2 \cdot h)$;
M is the increase in mass of the jar ($M_2 - M_1$), in mg;
d is the average diameter of the neck of the jar, in mm;
t is the time between the first and second weighing, in min.

5.13.2 Determination of water vapour absorption

5.13.2.1 Principle

An impermeable material and the test piece are clamped over the opening of a metal container, which holds 50 ml of water, for the duration of the test.

Water absorption of the test piece is determined by its difference in mass before and after the test.

5.13.2.2 Apparatus

5.13.2.2.1 Circular metal container, of volume 100 cm³ and an upper ring, between which the impermeable material and the test piece are clamped (see figure 29). The container and the ring have an internal diameter of 3,5 cm which correspond to a test area of approximately 10 cm². The upper ring is clamped to the apparatus with three hinged bolts equipped with wing nuts.

5.13.2.2.2 Balance, capable of weighing to the nearest 0,001 g.

5.13.2.2.3 Stopwatch.

5.13.2.3 Preparation of test piece

Cut a test piece of 4,3 cm diameter.

5.13.2.4 Test procedure

Carry out the test in a conditioning atmosphere of 20 °C ± 2 °C and
65 % ± 2 % r.h.

Weigh the conditioned test piece and record its mass, M_1.

Place 50 ml of water into the container and place the test piece over the
container with the side facing the foot downwards. Place the rubber or metal
disc and the upper ring over the test piece and screw down firmly. Ensure that
no water laps against the bottom of the test piece.

Remove the test piece after 8 h and weigh immediately, recording its mass,
M_2.

5.13.2.5 Calculation and expression of results

Calculate the water vapour absorption from the equation:

$$WVA = \frac{M_2 - M_1}{a}$$

where

> WVA is the water vapour absorption, in mg/cm^2;
> M_1 is the initial mass of the test piece, in mg;
> M_2 is the final mass of the test piece, in mg;
> a is the test surface area, in cm^2.

Round the result to the nearest 0,1 mg/cm^2.

5.13.3 Determination of water vapour coefficient

Calculate the water vapour coefficient from the following equation:

$$WVC = 8WVP + WVA$$

where

> WVC is the water vapour coefficient in mg/cm^2;
> WVP is the water vapour permeability in $mg/(cm^2 \cdot h)$;
> WVA is the water vapour absorption in mg/cm^2.

Round the result to the nearest 0,1 mg/cm^2.
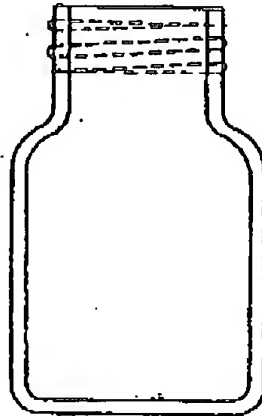
Dimensions in mm

Figure 26: Jar to be used
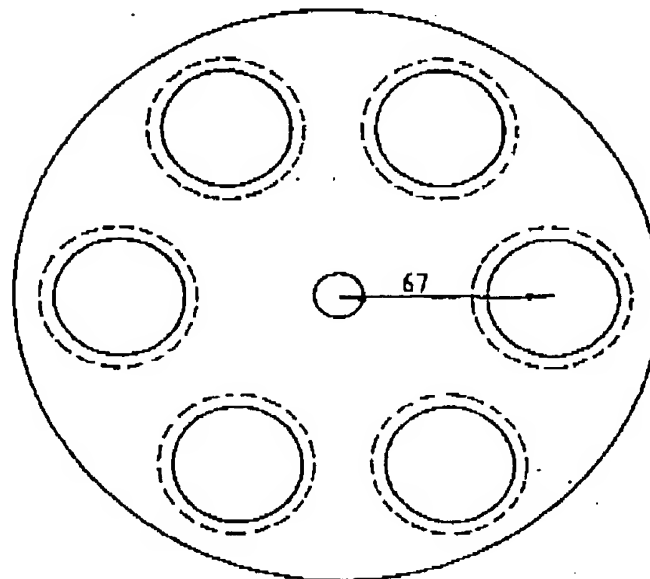in WVP test

Dimensions in mm

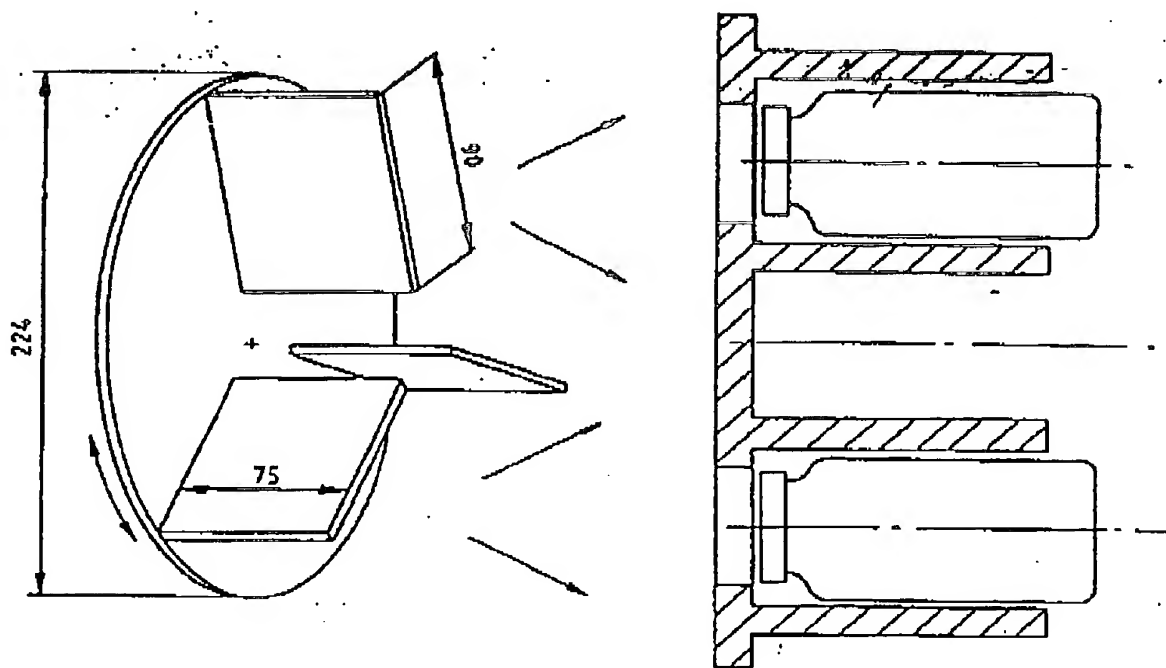Figure 27: Holder for jars
used in WVP test

Dimensions in mm

Figure 28: Schematic diagram of apparatus
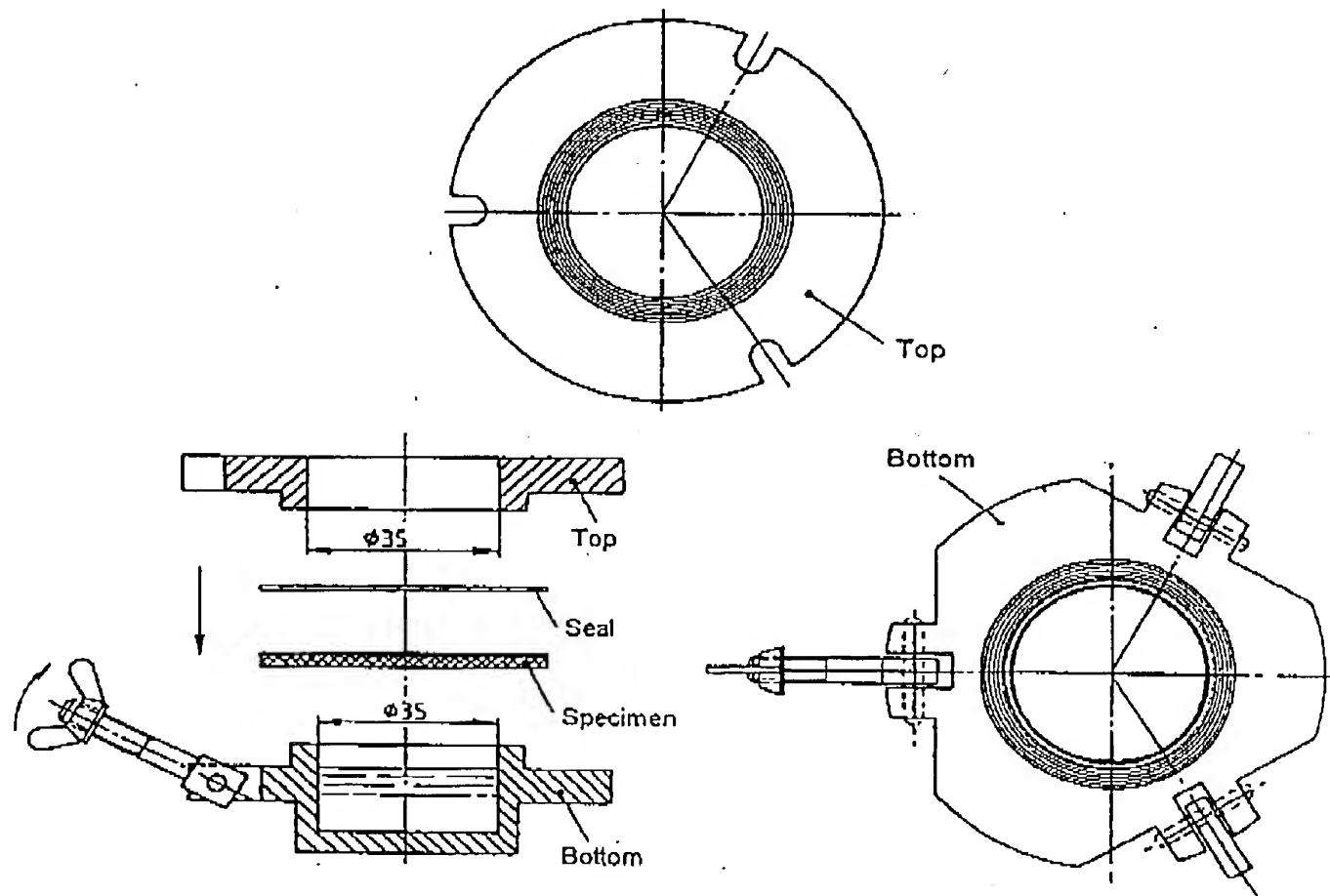to be used in WVP test

Dimensions in mm

Figure 29: Apparatus for determination of WVA

5.14 Determination of abrasion resistance of lining

5.14.1 Principle

Circular test pieces are abraded on a reference abradant under known pressure with a cyclic planar motion in the form of a Lissajous figure which is the resultant of two simple harmonic motions at right angles to each other. The resistance to abrasion is assessed by subjecting the test piece to a defined number of cycles at which point it shall not exhibit any holes.

5.14.2 Apparatus

5.14.2.1 Abrasion machine [2] of the type described by Martindale (J. Text. Inst. 1942 : 33, T151), and fulfilling the following requirements:

Rotational speed of each of the outer pegs	47,5 r/min ± 5 r/min
Drive ratio of outer pegs : inner pegs	32 : 30
Dimensions of the Lissajous figure	60 mm ± 1 mm
Symmetry of Lissajous figure	Curves shall be parallel and evenly spaced
Face diameter of specimen holder insert	28,65 mm ± 0,25 mm
Combined mass of specimen holder, spindle and weight	795 g ± 7 g
Parallelism of plate and abrading tables	± 0,05 mm
Circumferential parallelism	± 0,05 mm
Diameter of abradant base	140 mm (+ 1, − 2) mm

The test piece holders and abrading tables shall be plane and parallel over their entire surfaces. The drive from the motor to the machine shall be connected to a counter and switch so that the revolutions of the outer pegs are indicated and the machine may be stopped after a predetermined number of cycles has been measured by the counter.

5.14.2.2 Reference abradant,[2] consisting of a crossbred worsted spun, plain woven fabric, complying with table 13.

The reference abradant is mounted on the abrading tables of the machine over a piece of felt. The felt shall be woven felt of mass per unit area 750 g/m^2 ± 50 g/m^2 and 3 mm ± 0,5 mm thick, and need not be renewed until damaged or soiled on both sides or until approximately 100 h of testing have been completed.

Table 13: Reference abradant

	Warp	Weft
Yarn linear density	R63 tex/2	R74 tex/2
Threads per cm	17	12
Singles twist, turns per metre	540 ± 20 'Z'	500 ± 20 'Z'
Two-fold twist, turns per metre	450 ± 20 'S'	350 ± 20 'S'
Fibre diameter, µm	27,5 ± 2,0	29,0 ± 2,0
Mass per unit area of fabric, minimum g/m^2	195	
Oil content, %	0,9 ± 0,2	

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[2] Information on the availability of a suitable abrasion machine, reference abradant, felt and polyetherurethane foam may be obtained from the Secretariat of CEN/TC161.

5.14.2.3 Backing for test pieces having a mass per unit area less than
500 g/m², consisting of polyetherurethane foam* 3 mm ± 1 mm thick, of density
30 kg/m² ± 1 kg/m³ and indentation hardness 5,8 kPa ± 0,8 kPa, cut to the
same size as the test piece piece. Backings are renewed with every test.

5.14.2.4 Fabric punch or press cutter, to produce a test piece to fit the
holder, having diameter of 38 mm.

5.14.2.5 Weight, of mass 2,5 kg ± 0,5 kg and diameter 120 mm ± 10 mm.

5.14.2.6 Balance, capable of weighing to the nearest 0,001 g.

5.14.3 Atmosphere for conditioning and testing

The conditioning and testing atmosphere shall be 20 °C ± 2 °C and
65 % ± 2 % r.h.

5.14.4 Preparation of test pieces and materials

Using the fabric punch (5.14.2.4) cut four circular test pieces from the lining,
two for the dry test and two for the wet test. Expose the test pieces and
materials to the standard atmosphere for at least 24 h.

5.14.5 Procedure

5.14.5.1 General

Check that the top plate and abrading tables are parallel. Insert a dial gauge
through the spindle bearing and move the top plate by turning the drive shaft by
hand. The needle movement of the dial gauge shall be within ± 0,05 mm over the
whole surface of an abrading table. If machines are being used in which the
test piece holders are connected to the weights by spindles, assemble each empty
test piece holder and place each one in position on the appropriate abrading
table and insert the spindles. Use a feeler gauge to check for any gap between
the face of the holder insert and the table. The gap shall not be greater than
0,05 mm. Rock the spindle from side to side and recheck with the feeler gauge.
To avoid damaging abrading tables and metal inserts, do not run the machine with
metal inserts in contact with the uncovered abrading table.

5.14.5.2 Mounting test pieces

Remove the outer ring of a test piece holder together with the accompanying
metal insert. Insert the test piece centrally into the outer ring so that the
face to be abraded shows through the hole.

For test pieces of fabric having a mass per unit area less than 500 g/m²,
insert a disc of polyetherurethane foam (5.14.2.3) having the same diameter as
the test piece. Use a new backing for each test. Place the metal insert
carefully into the outer ring with its raised surface next to the test piece.
Complete the assembly of the test piece holder by screwing on the back plate
whilst pressing the face of the test piece firmly against a hard flat surface to
prevent wrinkling. Check that no wrinkling has occurred. Repeat for the
remaining test pieces.

5.14.5.3 Preparation of abradant and backer for the wet test

Thoroughly wet the fabric abradant and felt backer by one of the following methods:

   a)   soak overnight;

   b)   agitate thoroughly in water;

   c)   wet with a high pressure water jet.

Allow excessive water to drain and mount them according to 5.14.5.4.

Rewet the abradant fabric and felt at 6400 cycles by gradually pouring on up to 30 ml of water and lightly rubbing it with the fingertips. Place the weight (5.14.2.5) on the fabric and leave for a few seconds to squeeze out excess water.

5.14.5.4 Mounting abradant

Mount a new piece of the reference abradant (5.14.2.2) on each table with a piece of felt of the same dimensions beneath the reference abradant. Flatten the reference abradant by placing the weight (5.14.2.5) on its surface, and then position and tighten up the retaining frame evenly. Make sure that the reference abradant is held in place firmly and that there are no tucks or ridges.

5.14.5.5 Mounting test piece holders

Mount the test piece holders in the machine.

Every time a holder is taken from the machine to check the test piece, re-tighten the holder before it is replaced on the machine.

5.14.6 Method of assessment

Continue the test until either a hole forms in the test piece or 25600 cycles have been performed for the dry sample (12800 cycles for the wet test). If the fabric has a pile, only holes in the base fabric need to be taken account of.

5.15 Determination of water absorption and desorption of insole

5.15.1 Preparation of test piece

Take a test piece of dimensions 50 mm ± 1 mm x 50 mm ± 1 mm from the insole and condition for 24 h at 20 °C ± 2 °C and 65 % ± 2 % r.h.

5.15.2 Procedure

5.15.2.1 Water absorption

Weigh the test piece to the nearest 0.01 g, and record its mass, M_o.

Place the test piece in distilled water at 20 °C ± 2 °C for 8 h. Then remove it, dry off any drops of water still adhering to it using filter paper and reweigh it, recording its mass M_F.

Calculate the water absorption, W_A, as a percentage by mass using the following equation:

$$W_A = \frac{M_F - M_o}{M_o} \times 100$$

where

> M_o is the initial mass of the test piece, i.e. in the dry condition, in g;
>
> M_F is the final mass of the test piece, i.e. in the wet condition, in g.

Report the water absorption to the nearest 1 %.

5.15.2.2 Water desorption

On completion of the test specified in 5.15.2.1, condition the test piece for 16 h at 20 °C ± 2 °C and 65 % ± 2 % r.h. and then reweigh it, recording its mass M_R.

Calculate the water desorption, W_D, as a percentage by mass using the following equation:

$$W_D = \frac{M_F - M_R}{M_F - M_o} \times 100$$

where

> M_o is the initial mass of the test piece, in g;
>
> M_F is the final mass of the test piece, in g;
>
> M_R is the mass of the reconditioned test piece, in g.

Report the water desorption to the nearest 1 %.

5.16 Determination of abrasion resistance of insole

5.16.1 Principle

The test piece is rubbed with pieces of wet, white wool felt, under a given pressure, with a number of to-and-fro motion cycles. The test is carried out on conditioned insole material, and abrasion damage is assessed visually.

5.16.2 Apparatus [3]

5.16.2.1 Test equipment, incorporating the following features:

a) carriage, with a horizontal, completely planar metal platform, a holder for fastening the material leaving 80 mm freely exposed and a device which allows the test piece to be maintained under a slight tension in the direction of the rubbing;

b) finger, of mass 500 g, removable but able to be fixed firmly, with a base of 15 mm x 15 mm, a device for attaching pieces of wool felt (5.16.2.2) to the base, an additional mass of 500 g and a means of guiding the finger when fully loaded (total mass 1 kg) flat on the test piece;

c) means for driving the carriage to and fro, with an amplitude of 35 mm and a frequency of 40 cycles/min ± 2 cycles/min.

NOTE: The following items are convenient, but not essential parts of the equipment:

- means to move the finger at right angles to the direction of rubbing, so that two or three tracks may be used for rubbing on one test piece;

- means for pre-selecting a given number of cycles.

5.16.2.2 Abradant pads, comprising square pieces of wool felt, 15 mm x 15 mm, punched out of a sheet of pure white wool felt with the following specification:

a) mass per unit area of 1750 g/m^2 ± 100 g/m^2;

b) mean water uptake of 1,0 ml ± 0,1 ml;

c) pH of 5,5 to 7,0 for an extract prepared by shaking 5 g of ground felt with 100 ml distilled water for 2 h in a polyethylene bottle.

5.16.3 Preparation of test piece

Cut a rectangle of minimum dimensions 120 mm x 20 mm.

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[3] Information on the availability of suitable apparatus may be obtained from the Secretariat of CEN/TC161.

5.16.4 Preparation of abradant pads

Condition the abradant pads (5.16.2.2) at 20 °C ± 2 °C and 65 % ± 2 % r.h. for 48 h and then weigh.

For each test piece, place four abradant pads in distilled water, heat to boiling and allow to boil gently until they sink. Then decant the hot water and replace with cold, distilled water, until the pads have reached room temperature.

Before use, take each pad from the water and squeeze or wipe it against the rim of a beaker so that it no longer drips.

Verify that the water uptake of each pad is 1,0 ml ± 0,1 ml, by weighing.

> NOTE: The pads should not be allowed to soak in water for more than 24 h before use.

5.16.5 Procedure

Fasten the test piece on to the apparatus and apply a slight tension to hold it flat.

Attach a wet pad to the finger and place the finger 5 mm from one edge of the test piece. Attach the additional mass of 500 g to the finger.

Carry out 100 cycles, lift the finger, and examine the test area for abrasion damage.

Replace the pad with a fresh one and carry out a further 100 cycles.

Replace the pad every 100 cycles and stop the test at the first indication of surface tearing or after 400 cycles, whichever occurs first.

5.16.6 Method of assessment

Examine the abraded surface of the test piece visually and note any surface tearing.

5.17 Determination of flexing resistance of outsole

5.17.1 Apparatus

5.17.1.1 Testing device, as illustrated in figure 30. The test piece is guided in such a way that on one side it can be bent at an angle of 90° about a mandrel with a radius of 15 mm.

5.17.1.2 Cutting tool, as illustrated in figure 31.

5.17.1.3 Measuring magnifier, to enable the cut growth to be measured to 0,1 mm.

5.17.2 Preparation of test piece

Take the bottom of the footwear, separated from the upper, as the test piece.

5.17.3 Procedure

Clamp the test specimen in the testing device (5.17.1.1) in such a way that the greatest bending stress is applied to the ball area (flexing zone). Pierce the sole between the cleats at three points along the line of maximum bending stress (twice in the edge zone of the sole 10 mm from the edge and once in the middle) using the cutting tool (5.17.1.2). Carry out 30 000 cycles starting from an extended or stretched state, with the test piece undergoing deformation at a constant stroke value between 125 cycles/min and 150 cycles/min.

After 30 000 cycles, measure the length of the cuts on the test piece surface in the secured state under the maximum bending angle using the measuring magnifier (5.17.1.3).
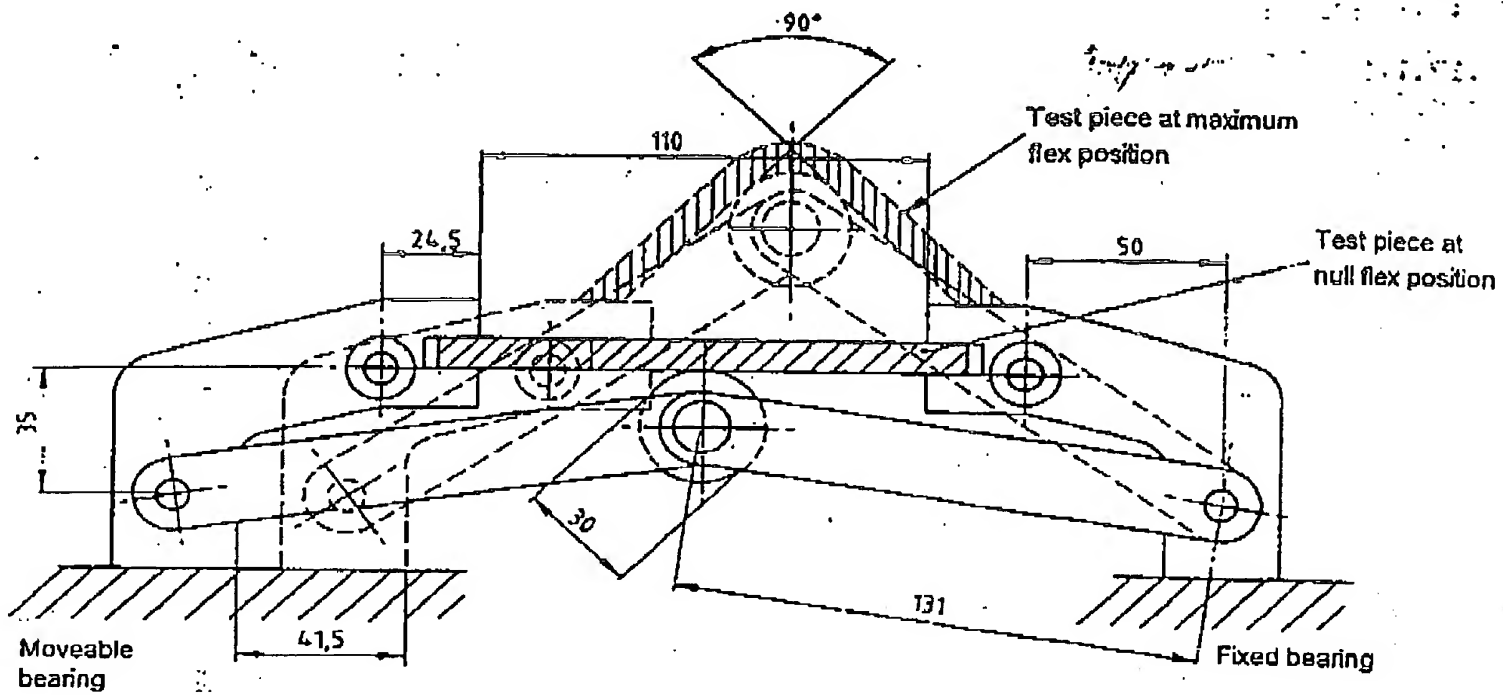
Dimensions in mm

Figure 30: Testing device for flexing
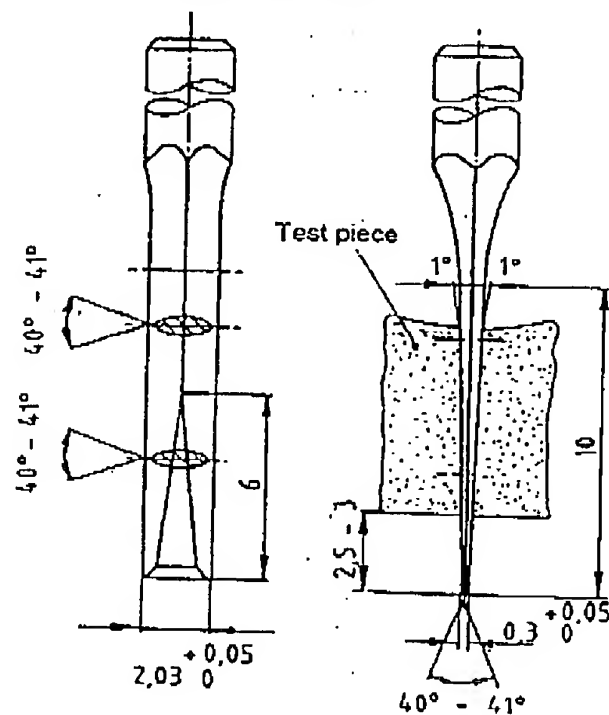resistance of outsole

Dimensions in mm

Figure 31: Cutting tool

5.18 Determination of resistance to hot contact

5.18.1 Apparatus

NOTE: A general arrangement of the apparatus is illustrated in figure 32.

WARNING: As toxic fumes may be released from some solings during this test it is necessary to site the apparatus in a well ventilated area.

5.18.1.1 <u>Cylindrical copper body</u>, referred to as the bit, of mass 200 g $\pm$ 20 g and with the lower end reduced to a flat square face with sides of dimension 25,5 mm $\pm$ 0,1 mm. The bit has a central longitudinal cavity of 6,5 mm diameter, extending to 4 mm from the outer working surface of the square end of the bit, to receive a temperature measuring device. The other dimensions of the bit are shown in figure 33.

5.18.1.2 <u>Metal heating block</u>, of mass 530 g $\pm$ 50 g, which surrounds the cylindrical part of the bit. This heating block contains an electrical resistance heating element and a means of control (an 'on/off' switch is sufficient) to pre-heat the bit to any desired temperature up to a maximum of 400 °C. The dimensions of the heating block are shown in figure 33.

5.18.1.3 <u>Device for measuring the internal temperature of the bit</u> close to its square end. A convenient way of measuring the temperature is a mercury-in-glass thermometer reading to 400 °C.

NOTE: For such a thermometer it is recommended that the small space between the thermometer bulb and the wall of the cavity be filled with a metal alloy having a melting point below 150 °C.

5.18.1.4 <u>Means of raising and lowering the bit</u>, together with the heating block, to bring its face into uniform contact with the test piece, in a horizontal plane and under a uniformly distributed pressure of 20 kPa $\pm$ 2 kPa.

5.18.1.5 <u>Self-aligning platform</u>, of suitable diameter, to receive the test piece and maintain uniform pressure on it.

5.18.1.6 <u>Hinged support with thermally insulated face</u>, on which the face of the bit rests during heating, and which can be moved aside to enable the bit to be lowered on the test piece.

5.18.1.7 <u>Mandrel</u> of 10 mm $\pm$ 1 mm diameter.

5.18.2 Preparation of test specimen

Cut a test piece of width 30 mm $\pm$ 2 mm and length 70 mm (minimum) from the sole and where necessary remove the cleats.

NOTE: Tests may be carried out in the waist region where there are normally no cleats. Where, however, the removal of the cleats would result in the removal of the wear layer, it is essential that the test piece is taken from the waist region.

Condition leather test pieces for 48 h at 20 °C $\pm$ 2 °C and 65 % $\pm$ 2 % r.h. before testing. For moulded PVC, allow at least 4 days to elapse after moulding before cutting and testing the test pieces.

5.18.3 Procedure

Switch on the heating block with the bit resting on the insulating support and
place the test piece on the platform below with its wear side uppermost. Cover
the test piece with aluminium foil to prevent contamination of the heated bit,
using a new piece of foil for each test. When the bit temperature has just
exceeded 300 °C switch off the heating block and allow the temperature to fall
to 300 °C ± 2 °C, with the bit still resting on its insulating support. Then
move the insulating support aside and immediately place the bit centrally on the
test piece, so that its sides are parallel to the side of the test specimen.
Leave it in position for 60 s ± 1 s without switching the heating block on again
and then replace it on the support.

Remove the foil, allow the test piece to cool for at least 10 min and examine
the heated part of its surface as described in 5.18.4.

5.18.4 Method of assessment

Assess the surface of the test piece visually for damage such as melting,
charring, cracking or crazing, both before and after bending it round the
mandrel. Record the type and severity of the damage. For leather soles record
whether charring or cracking is confined to the grain layer or whether any
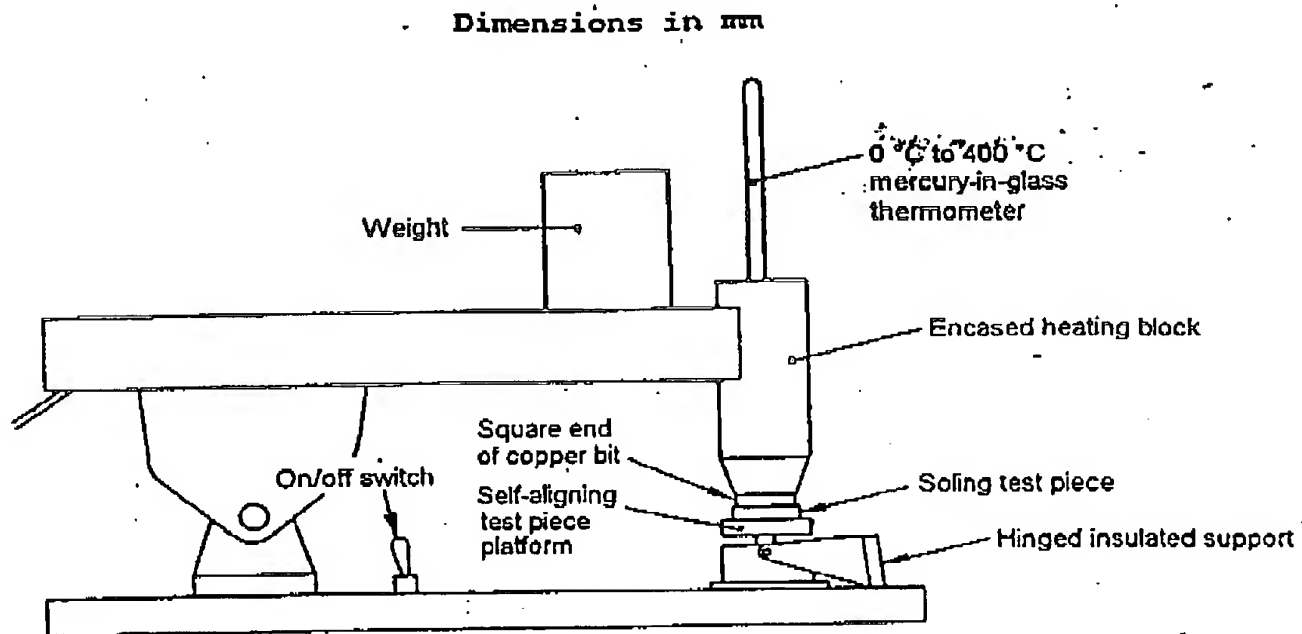penetrates into the corium.

Dimensions in mm

Figure 32: Apparatus for resistance to hot contact
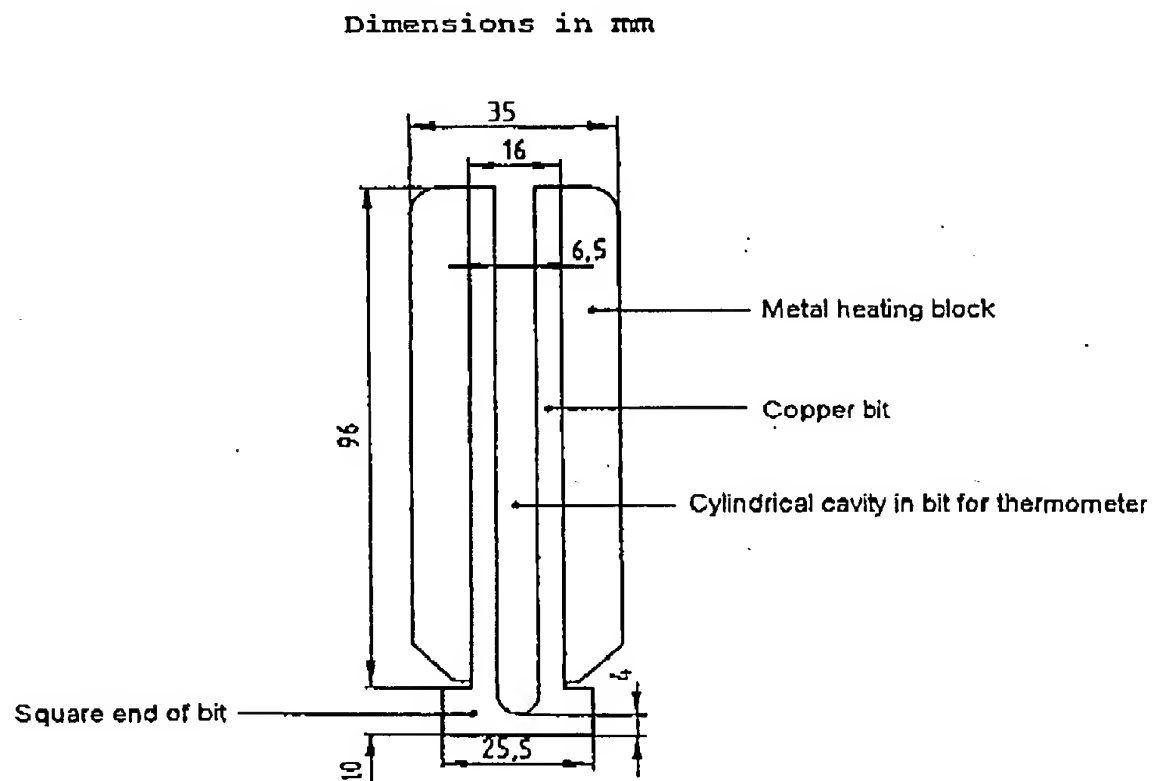
Dimensions in mm

Figure 33: Bit and heating block

5.19 Determination of resistance to fuel oil

5.19.1 General method

5.19.1.1 Test liquid

2,2,4-trimethylpentane, Analytical Reagent grade.

5.19.1.2 Preparation of test specimen

From the outsole, cut two pieces of 16 mm ± 1 mm diameter and 4 mm ± 0,5 mm thickness and test together as a single test piece.

5.19.1.3 Test procedure

Follow the general procedure described in 8.2 of ISO 1817 : 1985.

Immerse the test piece in the test liquid (5.19.1.1) at a temperature of 20 °C ± 2 °C for a period of 22 h ± 0,25 h.

Determine the increase in volume of the test piece using the volumetric method.

If the test piece shrinks or becomes brittle when tested in accordance with this procedure, take a further test piece, as described in 5.19.2.2, and test in accordance with 5.19.2.

5.19.2 Method for outsole materials which shrink or become brittle

5.19.2.1 Test liquid

As described in 5.19.1.1.

5.19.2.2 Preparation of test piece

Take a test piece of nominal width 25 mm and nominal length 150 mm from the outsole of the footwear and reduce to an overall thickness of 3 mm ± 0,2 mm by roughing or scouring.

5.19.2.3 Test procedure

Immerse the test piece in the test liquid at a temperature of 20 °C ± 2 °C for a period of 22 h ± 0,25 h.

Remove excess liquid with absorbant paper and determine the cut growth in the specimen after 150 000 cycles in accordance with the method described in Annex C of ISO 4643 : 1992.

Annex A
(informative)

Recommended methods for the assessment of toecaps to be used in safety or protective footwear

A.1 Recommended properties and performance

A.1.1 Material

Toecaps should be finished so as to be free from surface marks or defects and should have no sharp edges or corners.

A.1.2 Corrosion resistance

All internal toecaps should be corrosion resistant. Metal toecaps may be assessed and tested by the method described in A.2.1 and both before and after testing they should exhibit no more than five areas of corrosion, none of which should exceed 2,5 mm^2 in area.

A.1.3 Dimensions

When measured in accordance with the method described in 5.2, the internal length of toecaps should be not less than the appropriate value given in table 3.

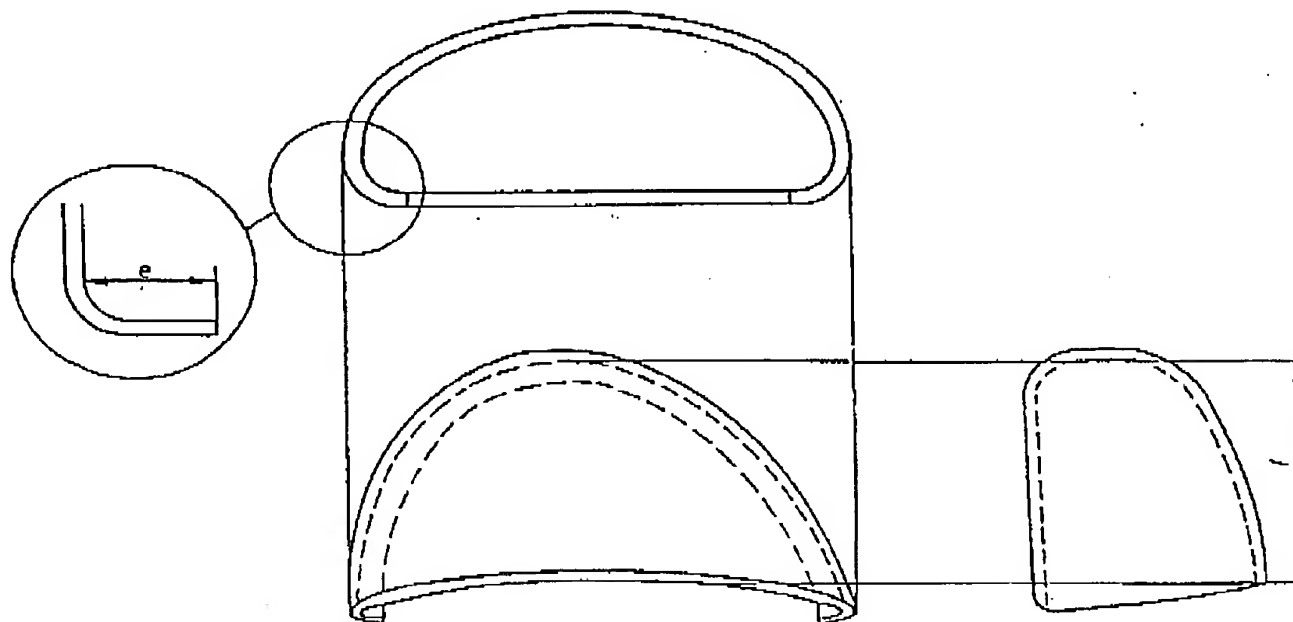If toecaps are formed with a flange, the width, e, of the flange should be no greater than 10 mm. See figure A.1.

Figure A.1: Illustration of toecap length, l, and flange width, e

A.2 Test methods to assess properties and performance of toecaps

A.2.1 Determination of corrosion resistance

A.2.1.1 Preliminary examination

Examine each toecap visually inside and outside for signs of corrosion under the coating and for corrosion occurring where the coating has broken down.

> NOTE: If necessary the coating may be removed to aid this examination although if this is done, the toecap will need to be replaced with another sample for the corrosion test.

Measure the size of each area of corrosion and note the number of such areas.

If a supporting jig is used during the coating disregard a circular area of 8 mm diameter around the jig contact points.

A.2.1.2 Corrosion test

Remove any coatings of grease which may be present.

Use a 1 % (m/m) aqueous solution of sodium chloride as the test solution. Pour approximately 200 ml of this solution into a porcelain dish and cover with a sheet of glass leaving a small opening.

Dip two strips of white filter paper of dimensions at least 100 mm wide and 150 mm long into the test solution at one end so that the strips of filter paper become saturated with solution, the other ends being laid on the sheet of glass.

Lay the toecap to be tested flange down over the free end of one filter paper so that the whole flange is in contact with the wetted area and lay the other filter paper over the toecap so that the greatest possible area of the nose of the cap and its upper surface is in contact with the filter paper. (See figure A.2). Ensure that the filter paper remains saturated throughout the test.

After 48 h remove the filter paper and examine the toecap for signs of corrosion caused by the sodium chloride solution. Measure the size of each area of corrosion in mm^2 and note the number of such areas.
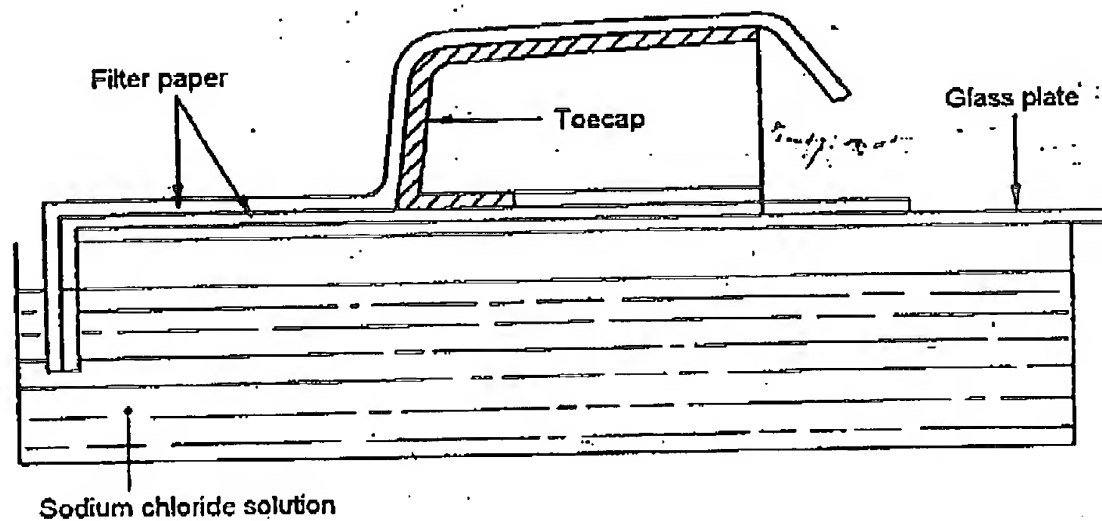
Figure A.2: Apparatus for corrosion resistance test for toecaps

A.2.2 Determination of impact resistance

A.2.2.1 Apparatus

A.2.2.1.1 Impact apparatus, as described in 5.3.1.1

A.2.2.1.2 Clamping device, consisting of a steel plate at least 19 mm thick and 150 mm x 150 mm in area and of minimum hardness 60 HRC with provision for lightly clamping a toecap in a way which will not restrict any lateral expansion of the cap during the impact test.

An example of a suitable clamping device is shown in figure A.3

The toecap is held in position at the front end with a forked clamp which is fitted with a milled screw into one of four threaded holes depending on the size of the toecap.

The toecap is held at the rear end with a radiused plate which is screwed to a sliding rail. The radiused plate lies over the flange at the back edge of the cap and pushes the cap against the forked clamp with a load of 100 N to 200 N.

The sliding rail is sprung such that when the toecap is hit by the striker it can move back along its axis against the spring. To change the toecap the radiused plate is retracted by releasing the clamping handle.

A.2.2.1.3 Cylinders, of modelling clay, of diameter 25 mm ± 2 mm and of height 25 mm ± 2 mm for toecaps intended for use in footwear up to and including size 40 and 30 mm ± 2 mm for toecaps for footwear above size 40.

A.2.2.1.4 Dial gauge, with hemispherical foot of 3,0 mm ± 0,2 mm radius and a flat base, exerting a force of not greater than 250 mN.

A.2.2.2 Procedure

A.2.2.2.1 Determination of the test axis

Determine the test axis as described in 5.2.2.

A.2.2.2.2 Preparation of test piece

Use the toecap as the test piece.

A.2.2.2.3 Test Procedure

Hold the test piece in the clamping device (A.2.2.1.2) so that when the striker hits it, the striker will project over the front and back of the toecap.

Position a cylinder (A.2.2.1.3) on one of its ends inside the toecap with the centre of the cylinder on the test axis and the back edge of the cylinder level with the rear edge of the toecap (see figure A.4)

Allow the striker to drop on to the test axis from the appropriate height to give an impact energy of 200 J $\pm$ 4 J for toecaps to be used in safety footwear or 100 J $\pm$ 2 J for toecaps to be used in protective footwear.

Measure, to the nearest 0,5 mm, the lowest height to which the cylinder has been compressed within 10 mm of the impression of the back edge of the toecap using the dial gauge (A.2.2.1.4). This value is the clearance at the moment of impact.

A.2.3 Treatment to assess thermal and chemical effects on the impact resistance of non-metal toecaps

A.2.3.1 Effect of above ambient temperature

Attach a thermocouple, capable of measuring to $\pm$ 0,5 °C and made from wires not exceeding 0,5 mm in diameter, to the top surface of the toecap using thin adhesive tape.

Place the toecap in an oven, which is maintained at 60 °C $\pm$ 2 °C for 4 h. Remove and allow to cool to 40 °C $\pm$ 2 °C before testing in accordance with A.2.2.2.3.

A.2.3.2 Effect of below ambient temperature

Attach a thermocouple, capable of measuring to $\pm$ 0,5 °C and made from wires not exceeding 0,5 mm in diameter, to the top surface of the toecap using thin adhesive tape.

Place the toecap in a chamber which is maintained at - 20 °C $\pm$ 2 °C for 4 h. Remove and allow the temperature to reach - 1 °C $\pm$ 1 °C before testing in accordance with A.2.2.2.3.

A.2.3.3 Effect of acid

Totally immerse the toecap in sulphuric acid, $c(H_2SO_4)$ = 1 mol/l, at 20 °C $\pm$ 2 °C for 24 h. Remove, wash off any excess acid with water and store at 20 °C $\pm$ 2 °C for 24 h before testing in accordance with A.2.2.2.3.

A.2.3.4 Effect of alkali

Totally immerse the toecaps in sodium hydroxide solution, $c(NaOH)$ = 1 mol/l, at 20 °C $\pm$ 2 °C for 24 h. Remove, wash off any excess alkali with water and store at 20 °C $\pm$ 2 °C for 24 h before testing in accordance with A.2.2.2.3.

A.2.3.5 Effect of fuel oil

Totally immerse the toecap in pure 2,2,4-trimethylpentane at 20 °C $\pm$ 2 °C for 24 h. Remove, wash off any excess liquid and store at 20 °C $\pm$ 2 °C for 24 h before testing in accordance with A.2.2.2.3.

Dimensions in mm

Forked clamp   Toecap   Radiused plate

Radiused plate

Spring

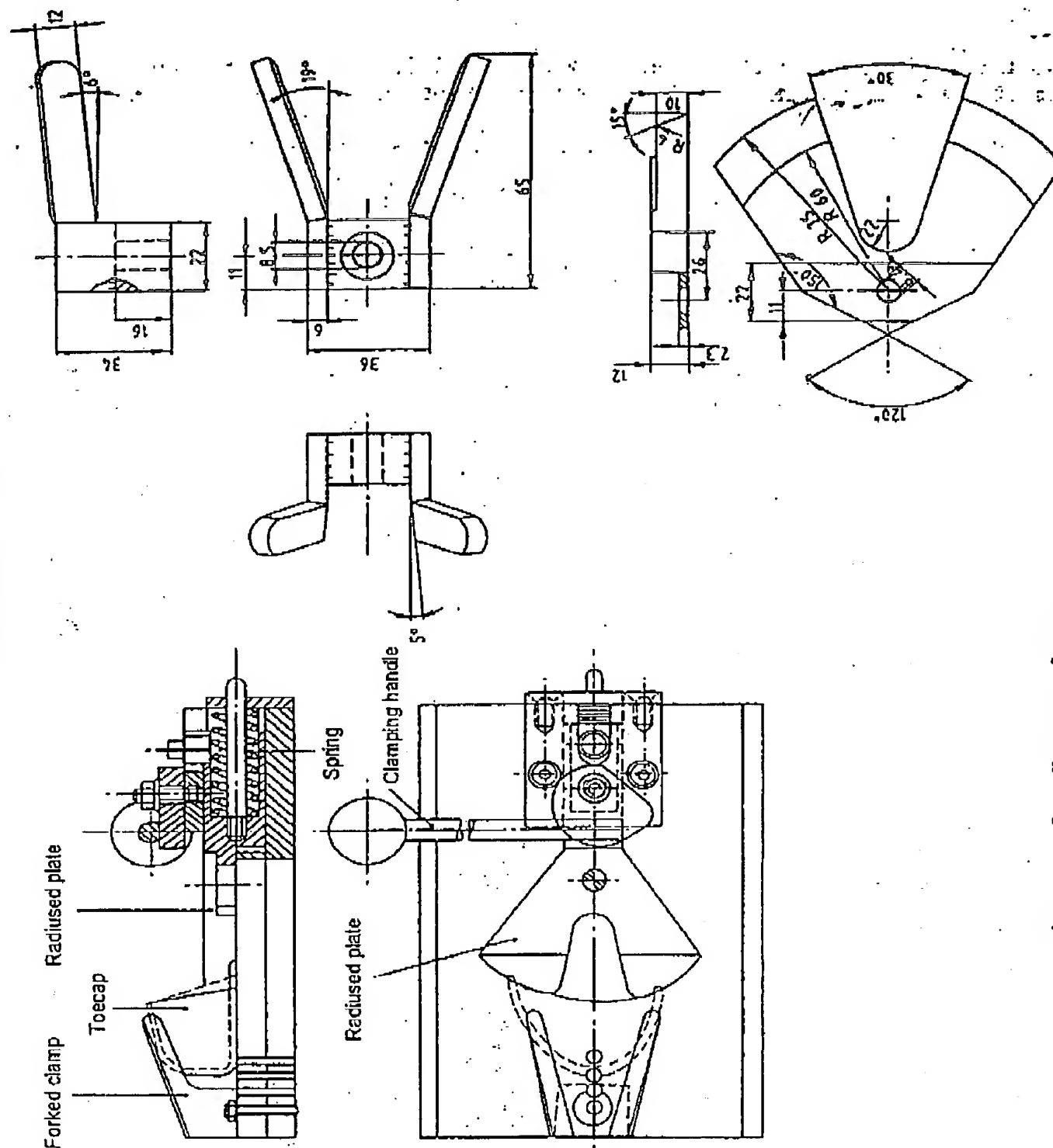Clamping handle

Radiused plate
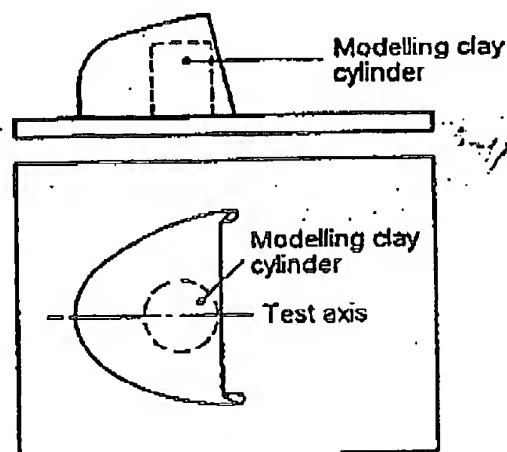
Figure A.3:   Toecap clamp

Figure A.4: Position of cylinder for
impact test of toecap

A.3 Marking

It is recommended that toecaps are clearly and permanently marked, for example by embossing, with the following information.

    a) size;
    b) right or left;
    c) manufacturer's identification mark;
    d) manufacturer's type designation.

Annex B
(informative)

Recommended methods for the assessment of penetration resistance inserts

NOTE: The following methods may be used to assess the performance of penetration resistant inserts before they are incorporated in footwear.

B.1 Recommended performance

B.1.1 Penetration resistance

When tested in accordance with the method described in B.2.1 the nail penetration force should be not less than 1100 N.

B.1.2 Flexing resistance

When tested in accordance with the method described in B.2.2, the penetration resistant insert should show no visible signs of cracking after it has been subjected to 1×10^6 flexes.

B.1.3 Corrosion resistance

When tested in accordance with the method described in B.2.3, the penetration resistant insert should exhibit no more than five areas of corrosion, none of which should exceed 2,5 mm^2 in area.

B.2 Test methods to assess recommended performance

B.2.1 Determination of penetration resistance

B.2.1.1 Apparatus

B.2.1.1.1 Test equipment, capable of measuring compressive forces up to at least 2000 N.

B.2.1.1.2 Test nail, as described in 5.6.1.2.

B.2.1.1.3 Clamping device, consisting of a jig to clamp the test piece in position and guide the test nail (see figure B.1). The nail is mounted in a solid metal cylinder of diameter 24,8 mm (0,00 mm, - 0,05 mm). The test piece is clamped between two rigid plates with circular apertures of diameter 25,00 mm ± 0,05 mm. One of the clamping plates is fitted with a cylindrical collar of internal diameter 25,00 mm ± 0,05 mm in which the cylinder slides so that the tip of the nail will be forced against the centre of the test piece.

B.2.1.2 Procedure

B.2.1.2.1 Preparation of test piece

Use the complete insert as the test piece and carry out four tests upon it. Alternatively, four test pieces, of dimensions 30 mm x 30 mm may be cut from the insert and each tested separately.

B.2.1.2.2 Test procedure

Clamp the test piece between the two plates, as shown in figure B.1, with its edge being at least 15 mm away from the tip of the nail. When the complete insert is being tested, ensure that any previous test perforation is at least 30 mm away from the tip of the nail.

Place the complete assembly between the plates of the test equipment, and run it at a speed such that the rate of penetration of the nail into the test piece is 10 mm/min ± 3 mm/min. Record the force in Newtons, at which it first stops increasing. Ensure that the whole length of the nail does not penetrate the test piece.

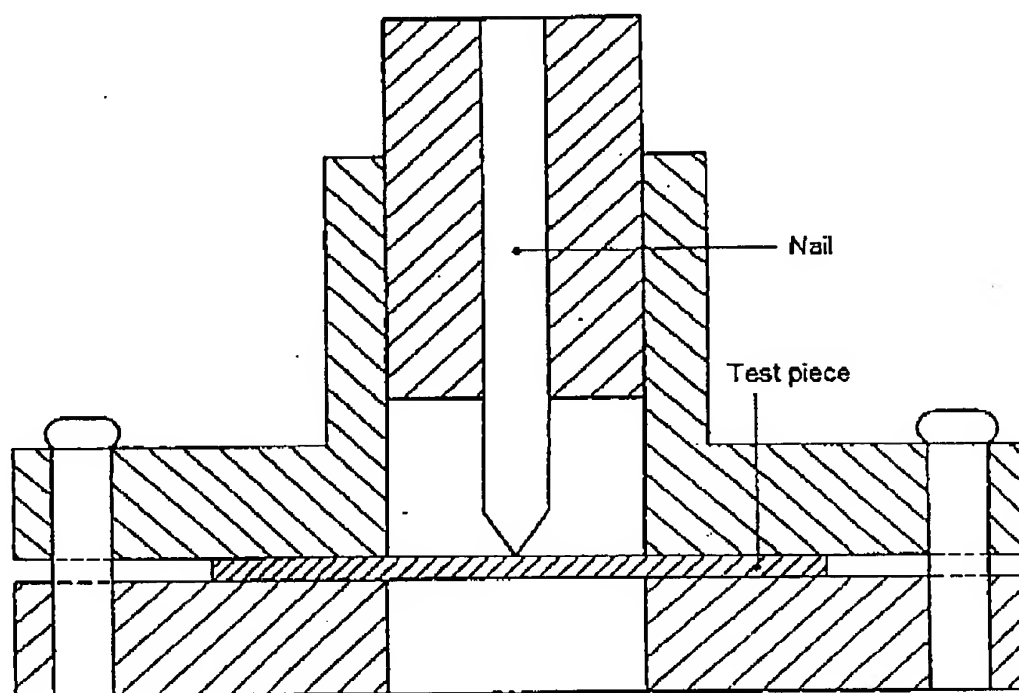Report the minimum value of the individual measurements as the test result.

Figure B.1: Schematic example of apparatus for penetration resistance test of inserts

B.2.2   Determination of flexing resistance

B.2.2.1   Flexing apparatus, comprising a reciprocating guide bar to move the free end of the insert through a specified distance at a defined rate and a clamping device consisting of two elastic interlayers 4 mm thick and of Shore A hardness 75 ± 5 with two metal clamping plates at least 130 mm wide. In the zero position, the guide acts at a distance of 70 mm ± 1 mm from the clamping plates (see figure B.2). In order to accommodate all sizes of inserts, the flexing line may be shifted by up to 10 mm in the direction of the heel (the shaded region in figure B.3).

B.2.2.2   Procedure

B.2.2.2.1   Determination of the flexing line.

Lay the insert with its inner edge against a straight line in such a way that this line is at a tangent to the insert in the joint and heel regions. At the tangent to the joint draw a perpendicular. This line is the flexing line at which the insert is clamped (see figure B.3).

B.2.2.2.2   Preparation of test piece

Cut off the heel part of the insert at a distance of 90 mm from the flexing line, as determined in B.2.2.2.1.

B.2.2.2.3   Test procedure

Deflect the test piece at a rate of 16 cycles/s ± 1 cycle/s by moving the guide bar to a height of 33 mm, measured vertically above the zero position. Ensure by means of a guide that the test piece returns to the zero position after every deflection.

After 1×10^6 flexes, carry out a visual examination of the test piece.
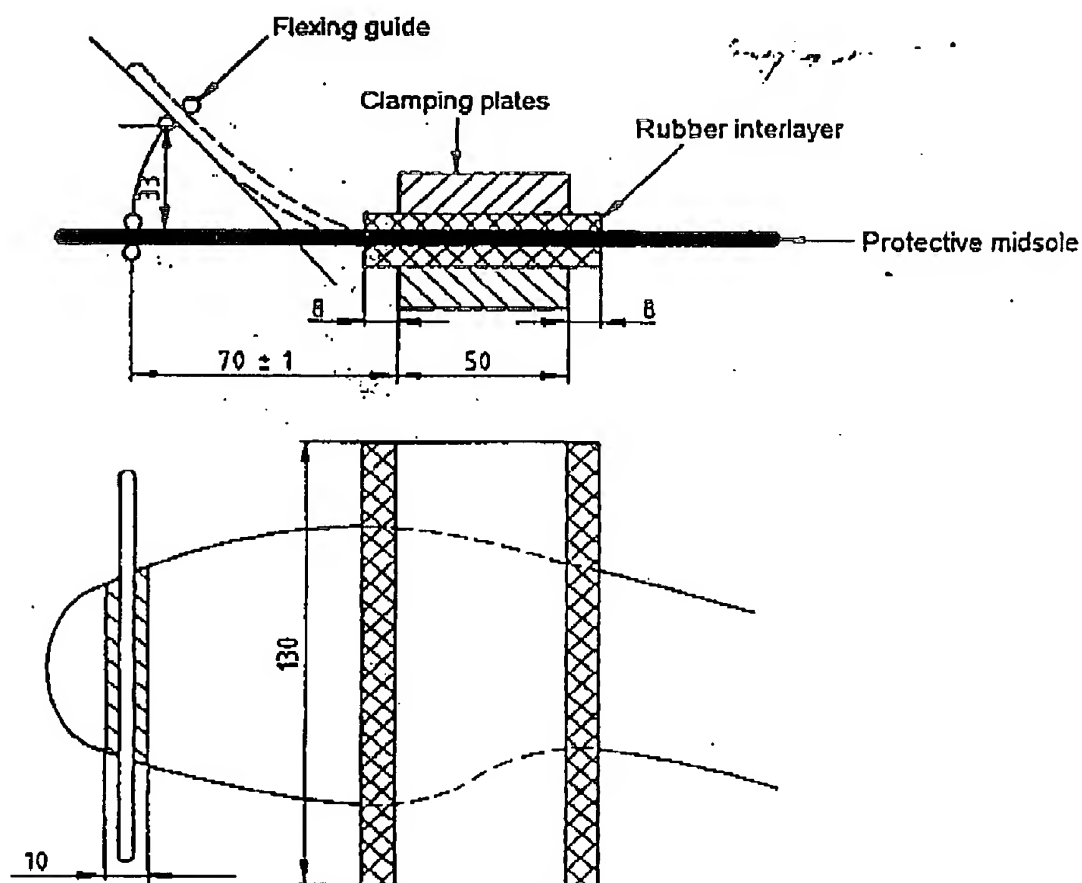
Dimensions in mm

Figure B.2   Flexing apparatus for penetration
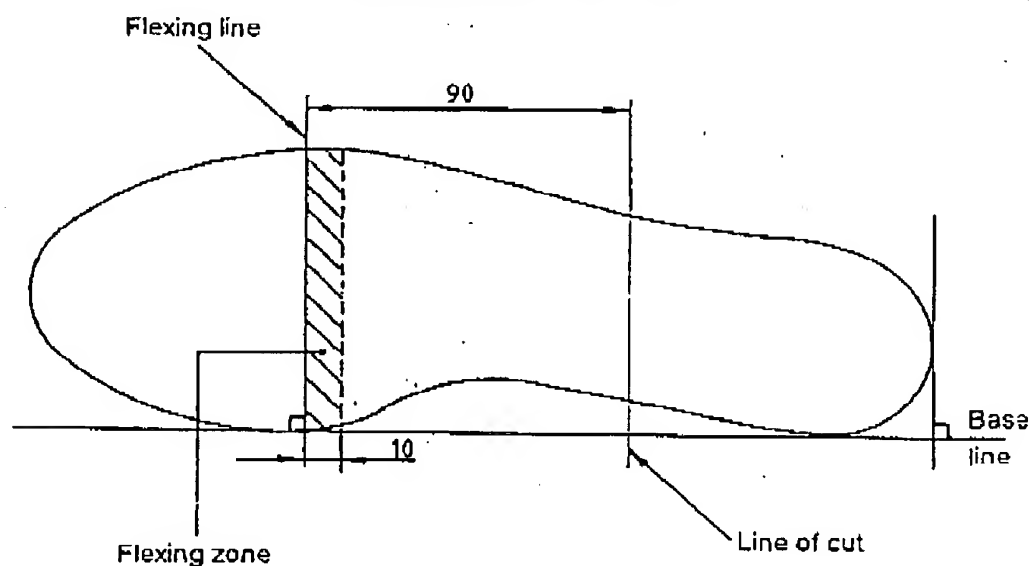resistance inserts

Dimensions in mm

Figure B.3:   Flexing line for inserts

B.2.3 Determination of corrosion resistance

B.2.3.1 Preliminary examination

Examine the insert as described in A.2.1.1.

B.2.3.2 Procedure

Test the insert as described in A.2.1.2, except that only a single strip of filter paper should be used. Place one end of the paper in the test solution and the other on the sheet of glass so that the complete insert may be placed upon it.

B.3 Marking

It is recommended that penetration resistant inserts are clearly and permanently marked, for example by embossing, with the following information.

    a) size;
    b) right or left;
    c) manufacturer's identification mark;
    d) manufacturer's type designation.